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SEMI-ANNUAL BULLETIN

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

National AMR Surveillance Network (NARS-Net)

Antimicrobial resistance (AMR) has emerged as a major public health threat requiring urgent prevention and control measures. Government of India has taken several initiatives to combat AMR. One of the key initiative in human health sector is the launch of the "National Programme on Antimicrobial Resistance (AMR) Containment" in 2013, during the 12th five-year plan (2012-2017). This programme is being coordinated by National Centre for Disease Control (NCDC), Delhi. One of the objective of the programme is to establish a laboratory-based AMR surveillance system in the country to generate evidence on AMR burden. 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 40 laboratories in 25 states and 6 UTs (Fig. 1). The sites perform bacterial culture, identification & antimicrobial susceptibity testing (AST) by manual methods and/or using automated systems.

In 2017 NCDC has been designated by MoHFW as the National Coordinating Centre for AMR Surveillance in the country and enrolled on the Global Antimicrobial Resistance Surveillance System (GLASS) for submission of country data annually. Antimicrobial Resistance data of selected WHO priority pathogens generated by healthcare laboratories under NARS-Net is collated and submitted to WHO-GLASS since 2018.

Currently NARS-Net sentinel sites conduct lab-based AMR Surveillance of nine priority bacterial pathogens namely *Staphylococcus aureus*, *Enterococcus* spp., *Escherichia coli*, *Klebsiella* spp., *Pseudomonas aeruginosa*, *Acinetobacter* spp., *Salmonella* Typhi & Paratyphi, *Shigella* spp., *Vibrio cholerae*, the last 2 pathogens have been included under surveillance since March 2023.

All the participating network sites report AMR data of priority pathogens isolated from 4 specimen types (blood, urine, pus & other sterile body fluids) to NCDC on a monthly basis. The network sites are mandated to ensure internal quality controls (IQC) within the laboratory and participate in External Quality Assessment Scheme (EQAS) to ensure the reliability of test results. Each quarter, the network sites submit defined number of isolates for EQAS to the National Reference Laboratory (NRL) located in Centre for Bacterial Diseases and Drug Resistance (CBDDR) at NCDC. In addition the sites are mandated to submit all emerging AMR alert isolates, as defined under the programme, to NCDC for confirmation.

The AMR programme unit at NCDC provides support to the sentinel surveillance network laboratories to ensure quality lab testing including bacterial identification and AST. 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 bi-annual bulletin includes AMR data from January 2023 to June 2023 from 39 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 72,481 priority pathogens has been reported 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 thorugh 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.

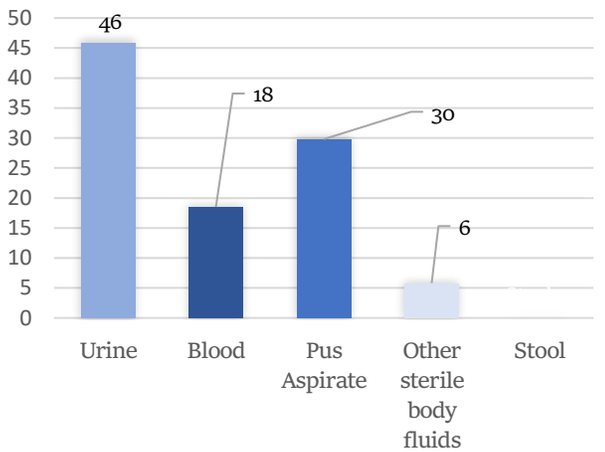


Fig. 1- Distribution of priority pathogen isolates based on specimen type, NARS-Net (Jan 2023-June 2023)

AMR Surveillance Profile

In the 2023 six-monthly AMR data (January to June 2023) reported from 67,505 unique patients, 53% male and 47% female patients, the most commonly isolated priority pathogen was *E. coli* (34%) followed by *Klebsiella* species (21%), *S. aureus* (13%), *Enterococcus* species (12%), *Pseudomonas* species (10%), *Acinetobacter* species (10%) and *Salmonella* enterica serovar Typhi and Paratyphi (0.4 %) (Table 1).

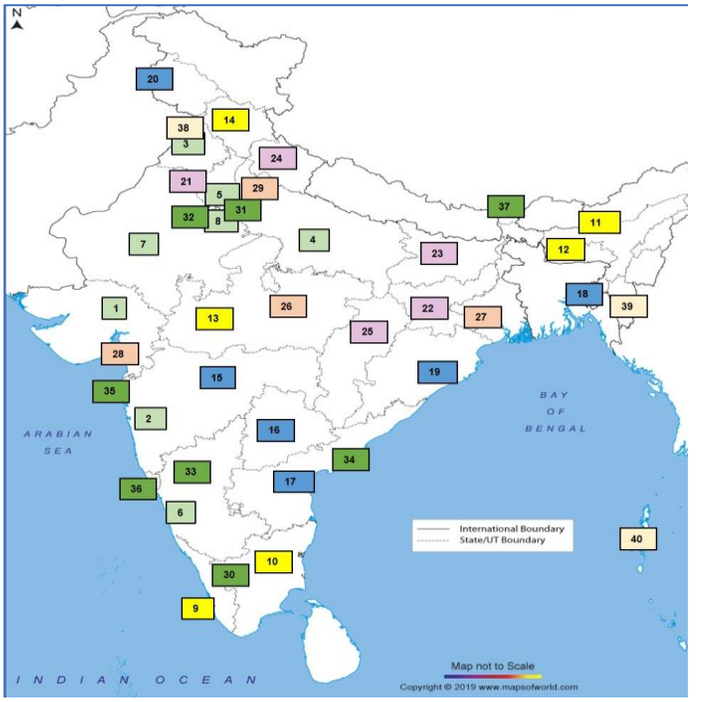


Fig. 2- Laboratories under National AMR Surveillance Network (NARS-Net)

The most common specimen type from which isolates have been reported in the current data reporting period was urine (51%). *E. coli* was the most commonly isolated pathogen from urinary specimens. From blood specimens, the most commonly isolated priority pathogen was *Acinetobacter* species (24%) and among pus aspirates, *S. aureus* (28%) was observed to be most commonly isolated (Table 1).

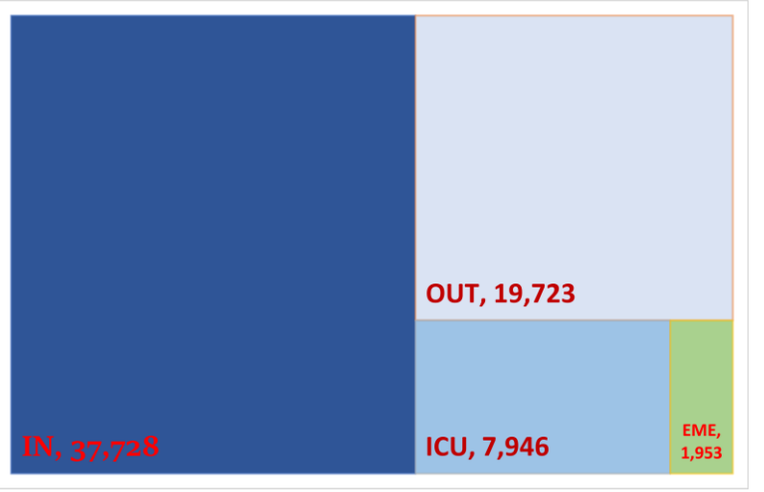


Figure 3- Distribution of priority pathogens isolates by location type (N=67,505), NARS-Net (Jan 2023-June 2023)
*155 isolate location type no-known

Table 1- Distribution of priority pathogen by specimen type (N=67,505), NARS-Net (Jan 2023-June 2023)

Priority Pathogen	Blood N	Blood (%)	Pus aspirate N	Pus aspirate (%)	OSBF# N	OSBF# (%)	Urine N	Urine (%)	Stool N	Stool (%)	Total N	Total (%)
Escherichia Coli	1361	(11)	4667	(23)	885	(23)	15801	(51)	x		22714	(34)
Klebsiella spp.	2630	(21)	4082	(20)	820	(21)	6714	(22)	x		14246	(21)
Salmonella Typhi and *Paratyphi*	275	(2)	x		x		x		3		278	(0.4)
Pseudomonas spp.	1235	(10)	3071	(15)	592	(15)	2156	(7)	x		7054	(10)
Acinetobacter spp.	2987	(24)	1879	(9)	892	(23)	1222	(4)	x		6980	(10)
Staph. aureus	2487	(20)	5616	(28)	332	(9)	x		x		8435	(13)
Enterococcus spp.	1510	(12)	790	(4)	377	(10)	5102	(16)	x		7779	(12)
Shigella spp.	x		x		x		x		5		5	(0.01)
Vibrio cholerae	x		x		x		x		14		14	(0.02)
Total	12485	(100)	20105	(100)	3898	(100)	30995	(100)	22		67505	(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 17,117 Gram positive cocci from unique patients was submitted to NCDC during the reporting period.

Staphylococcus aureus

Staph aureus constituted 13% of the priority pathogens included in this data (Table. 1). This data is from 8,435 unique patients. *Staph aureus* isolation from blood, aspirated pus, and sterile body fluids was 20%, 28%, and 9% respectively.

Fifty seven percent of these isolates from blood were MRSA 9Methicillin 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 (56%). Out of 5,445 isolates tested on Vancomycin screen agar, single isolate showed growth but was not confirmed using broth microdilution method.

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 and 5b)

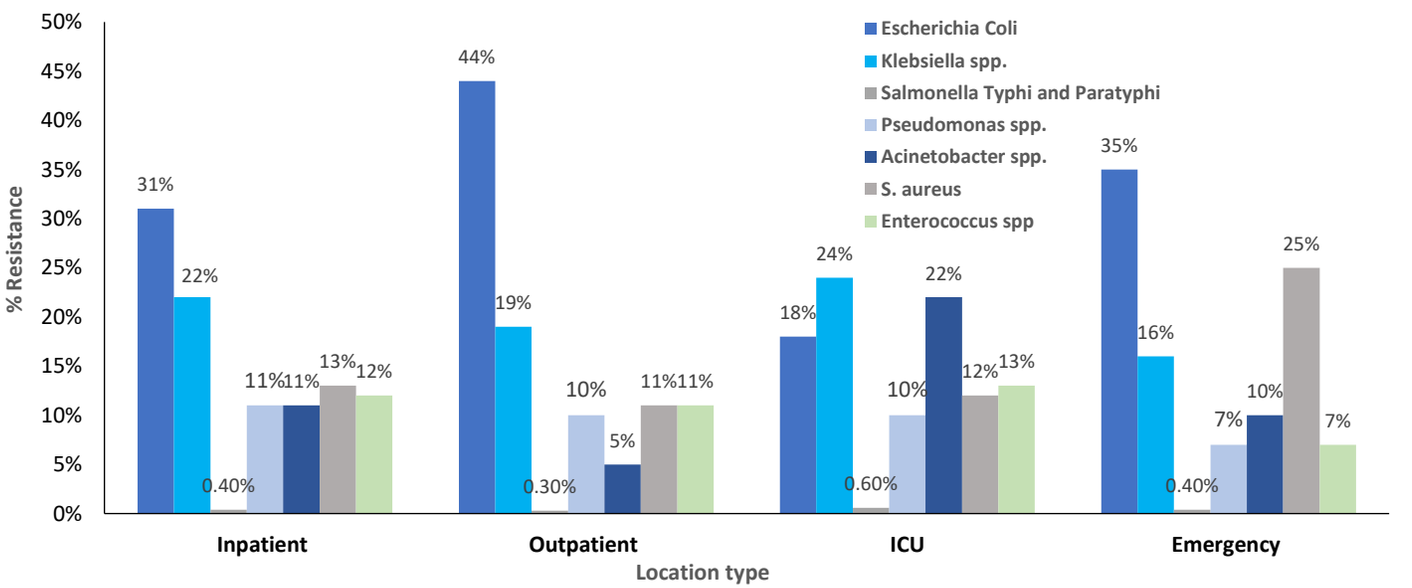


Figure 4- Distribution of each priority pathogen by location type (N=67,505)

Enterococcus species

Enterococcus species contributed 48% of the Gram-positive cocci. A total of 8,197 *Enterococcus* species isolate data was submitted by the NARS Net sites of which 7,779 isolates were from unique patients. Data analysis revealed, *Enteroccus* spp. isolation rate from specimen types like blood, pus aspirates, other sterile body fluids and urine were 12%, 4%, 10% and 16% respectively (Table 1).

Among *Enterococcus* species isolated from blood, Erythromycin resistance was observed to be 80% (CI: 77.6- 82.0) followed by Ampicillin 68%, (CI: 65.7-71.0). Similar resistance pattern was seen in isolated from other specimen types namely pus aspirate and sterile body fluids. Low resistance was reported to linezolid in *Enterocccus* spp. isolated from all specimen types - blood (1.48%), pus aspirate (0.42%), other sterile body fluid (1.68%) and urine (0.82%).

Among the urinary isolates, resistance was observed to ciprofloxacin (81%) and ampicillin (56%). Isolates from urine showed 7.6% resistance to vancomycin and 0.82 % resistance to linezolid.

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 55,364 gram-negative bacterial isolates has been reported from 51,291 unique patients during the period of January 2023 to June 2023 from 39 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 at the AMR-NRL at CBDDR NCDC have been included in this report.

Enterobacteriaceae

A total of 40,325 isolates were submitted from 37,243 unique patients.

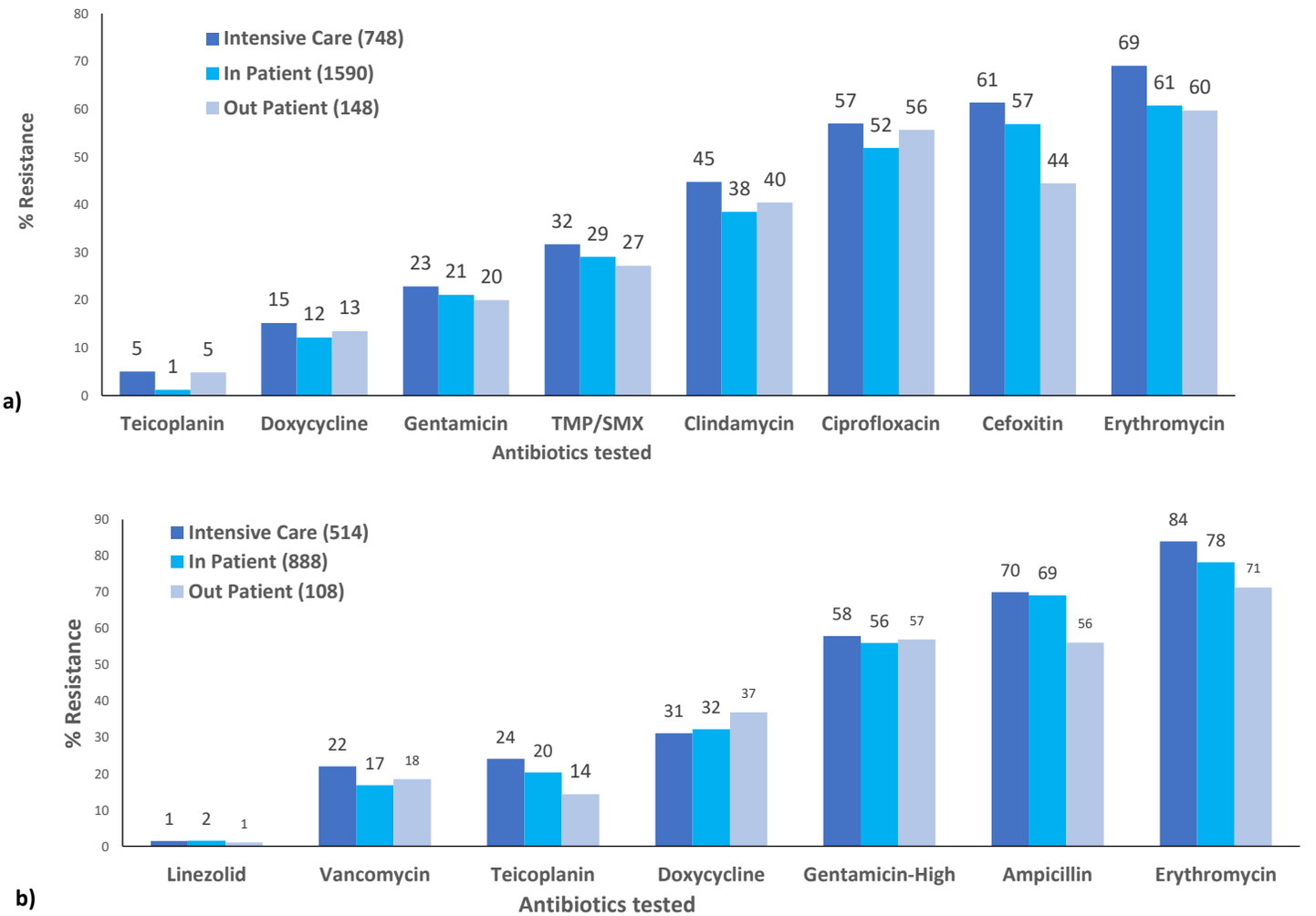


Fig. 6: Resistance profile of a) Staph aureus (N=2,487) and b) *Enterococcus* species (N=1,510) in blood, NARS-Net (Jan 23 - June 23)

Escherichia coli

A total of 24,686 *E. coli* isolates were reported from 22,714 unique patients and have contributed to one-third of the unique patient AST data. *E. coli* was mostly isolated from urine samples (51%) followed by sterile body fluids (23%), pus (23%) and blood (11%) (Table 1). With respect to the resistance pattern, the highest resistance in isolates from all the specimen types was observed to ampicillin (81-91%). Among the third generation cephalosporins, 80% (CI:77.9 - 82.9) resistance was observed to cefotaxime.

Resistance in blood isolates of *E. coli* was found to be 38% (CI:35.5-41.1) to imipenem and 32% (CI:29.3-35.7) to meropenem whereas among non-beta-lactam antibiotics, 67% (CI: 64.7-70.1) resistance was observed to ciprofloxacin and 54% (CI:50.7-56.7) to trimethoprim-sulfamethoxazole. Among urine isolates, 13% showed resistance to nitrofurantoin and 4% to fosfomycin. Seventy five percent of urine isolates were found to be resistant to third-generation cephalosporins. Six isolates from OSBF, one from pus aspirate and four from urine were resistance to colistin.

Klebsiella species

In this data, a total of 15,352 *Klebsiella* spp. were reported, of which 14,246 were from unique patients. Most of the *Klebsiella* spp. reported was from urine (22%) followed by blood (21%) and other sterile body fluids (21%) (Table 1).

Among the urine isolates, 71% were found to be resistant to a third generation cephalosporins. Resistance to ertapenem 47%; (CI:44.8-50) was highest amongst the carbapenems.

Among the urine isolates, amikacin resistance was observed in 38% (CI:36.4- 39.1) of isolates and 45% (CI: 44.0-46.6) showed resistance to nitrofurantoin.

Klebsiella spp. isolated from blood showed high resistance for second and third generation cephalosporins (86-88%). Meanwhile, the carbapenem resistance in *Klebsiella* spp isolated from blood was also found to be high 76%. Resistance to colistin was found to be highest in *Klebsiella* spp. among the gram-negative priority pathogens.

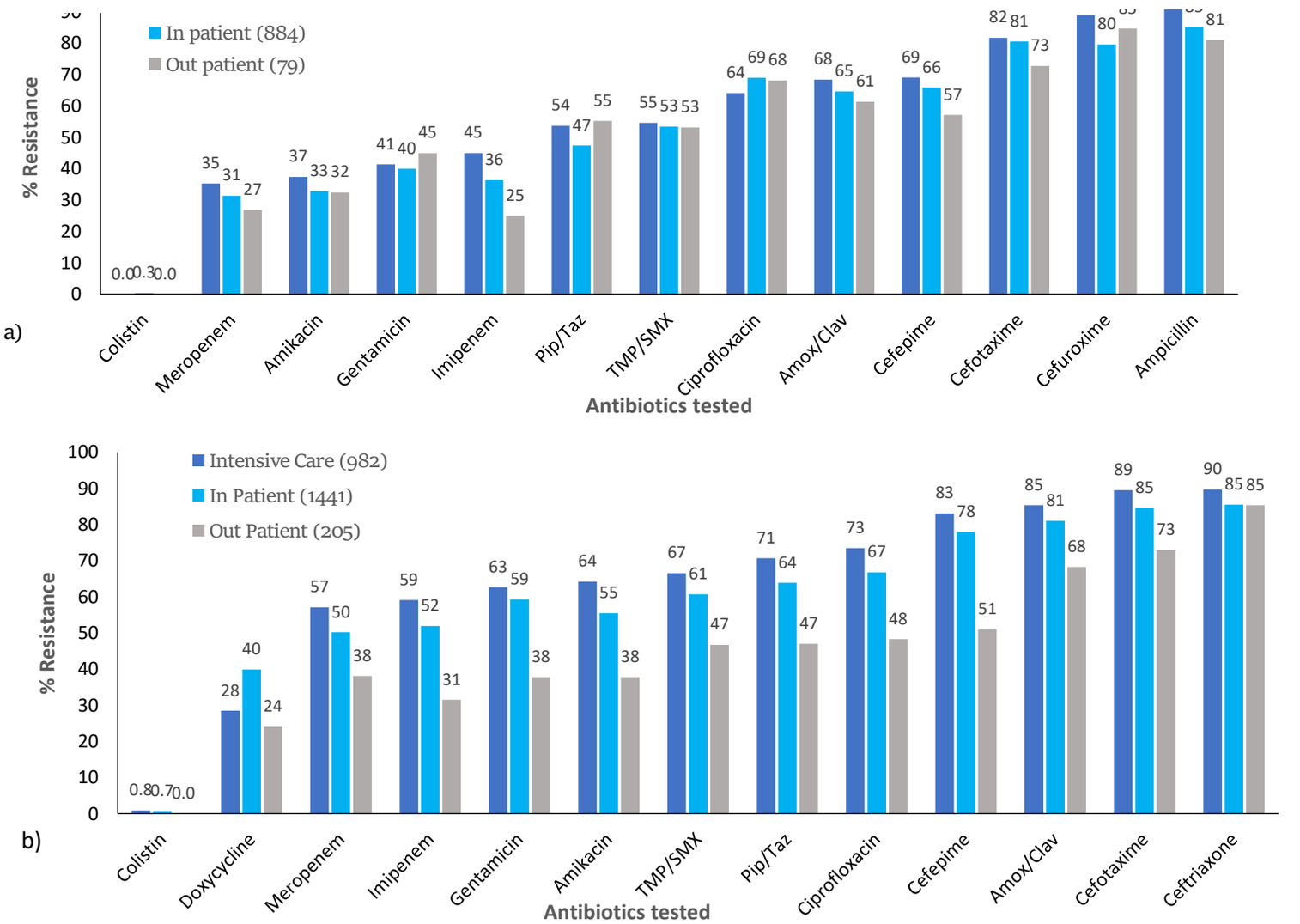
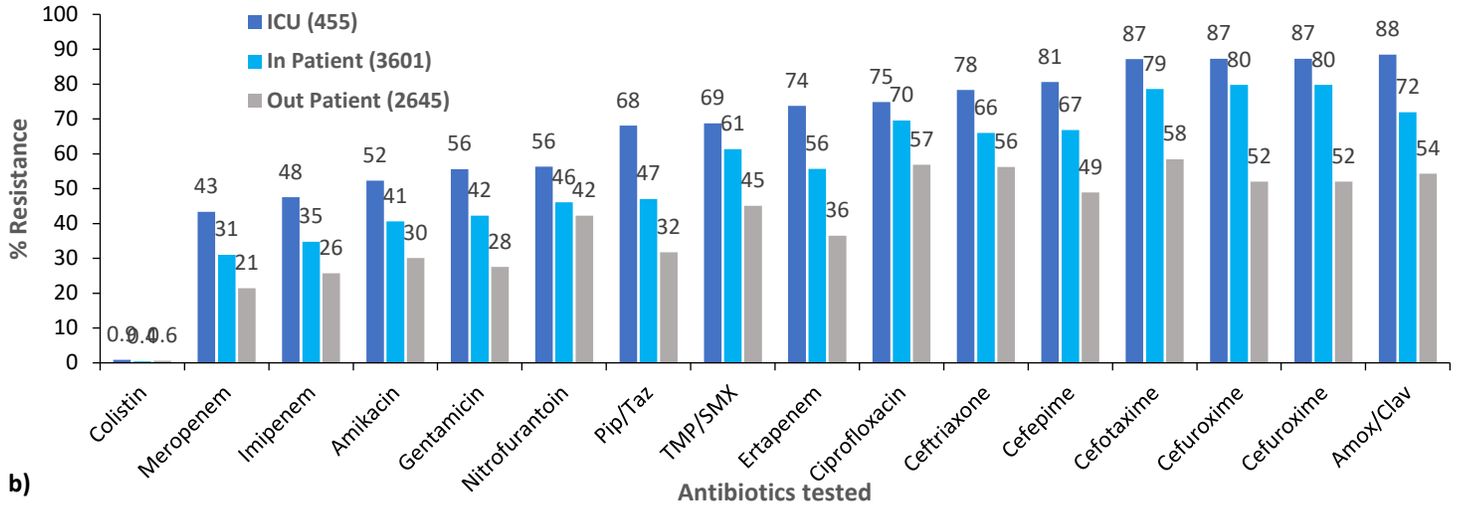


Fig. 6: Resistance profile of a) *E.coli* (N=1,361) and b) *Klebsiella* spp. (N=2,630) in blood by location type, NARS-Net (Jan 23 - June 23)



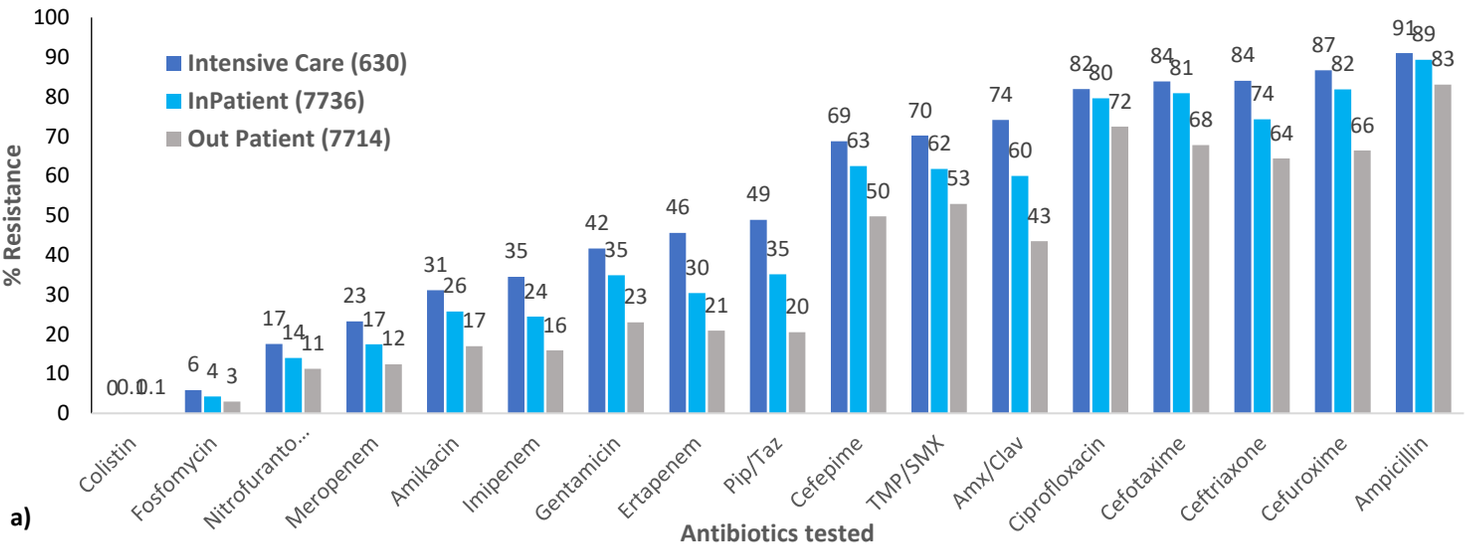


Fig. 7: Resistance profile of a) *E.coli* (N=1,361) and b) *Klebsiella* spp. (N=2,630) in urine by location type, NARS-Net (Jan 23 - June 23)

The location type wise AST of *E.coli* and *Klebsiella* spp. revealed a higher resistance rates in samples isolated from intensive care units when compared to inpatient wards and outpatient clinics (Fig. 8a and 8b). Six isolates of *Klebsiella* sp. from blood of ICU patients and seven isolates of inpatients

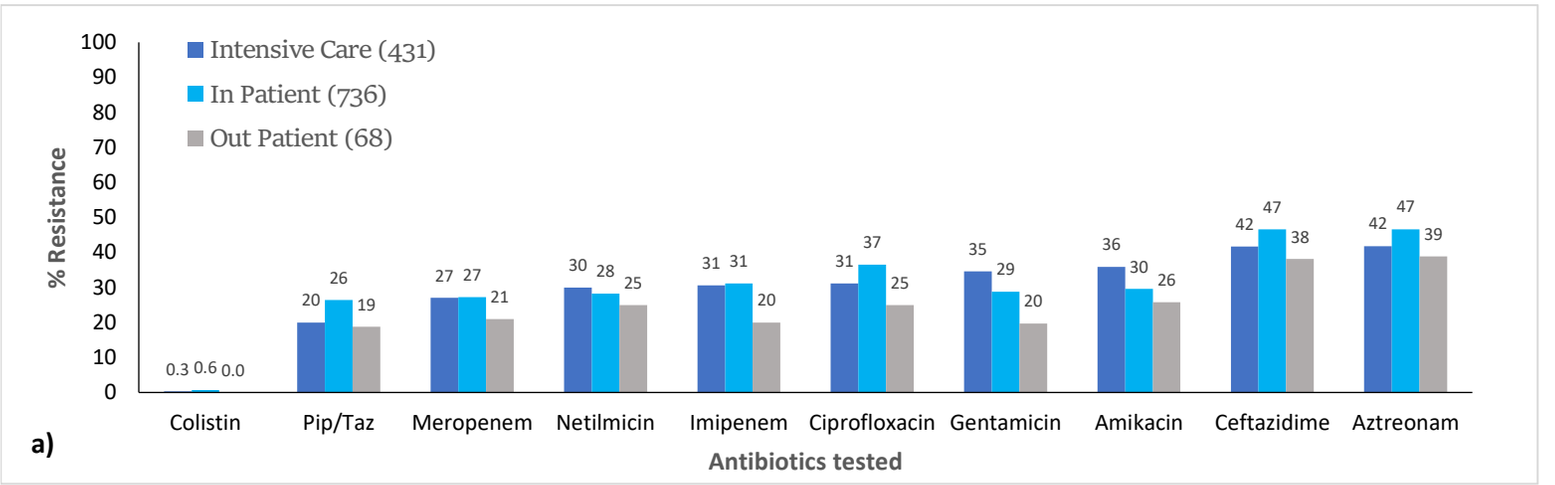
Salmonella enterica ser. Typhi and Paratyphi

Of the 278 *Salmonella* enterica ser. Typhi and Paratyphi isolates reported, 3 were isolated from stool and remaining from blood specimens. Compared to ciprofloxacin (41%), lower resistance to first-line antibiotics namely ampicillin, chloramphenicol and trimethoprim/ sulfamethoxazole was observed. (Table 2).

Table 2: Resistance profile of Salmonella seovar Typhi & Paratyphi from blood, NARS-Net (Jan 23 – June 23)

Antibiotic tested	*S. Typhi* (N=241)			*S. Paratyphi* (N=34)	
	Number tested	Resistance (%)	95% CI	Number tested	(Number Resistant)
Ampicillin	225	(8.4)	5.3-13.1	32	(1)
Azithromycin*	219	(0)	0.6-4.9	-	
Ceftriaxone	225	(0)	0.2-3.5	31	(0)
Chloramphenicol	221	(1.4)	0.4-4.2	33	(1)
Ciprofloxacin	240	(41)	34.6-47.4	34	(6)
Imipenem	229	(1)	0.8-5.3	29	(0)
Trimethoprim/Sulfamethoxazole	237	(5.5)	3.1-9.4	-	

*AST for azithromycin is performed only on isolates of *Salmonella* Typhi



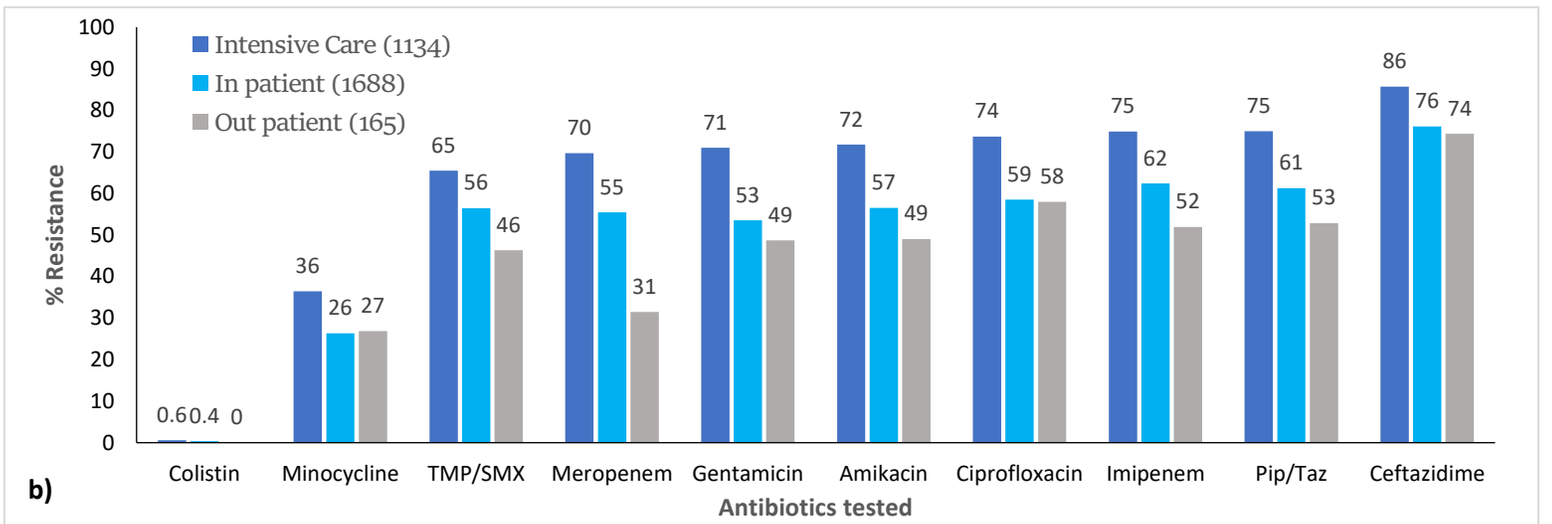


Fig. 8 - Resistance profile of a) *Pseudomonas* species (N=1,235) and b) *Acinetobacter* species (N=2,987) in blood, NARS-Net (Jan 23 - June 23)

Non-Fermenting Gram-Negative Bacilli

Among the Non-fermenting Gram-negative bacilli collected during Jan-June 2023 across all NARS-Net sentinel sites, *Pseudomonas* species (7,054) was the most isolated pathogen followed by *Acinetobacter* species (6,980) (Table 1). *Pseudomonas* species was predominantly isolated from inpatients (11 %), while *Acinetobacter* species was isolated mostly from patients in ICU—settings (22 %). (Fig.6)

Pseudomonas species

A total of 7,588 of *Pseudomonas* species isolates were reported from 7,054 unique patients. The isolation rate of *Pseudomonas* species was 10% from blood, 15% each from pus aspirates and from sterile body fluids and 7% from urine. (Table 3)

About 55% of isolates froom urine were resistant to the third generation cephalosporin namely ceftazidimwas observed to the non-beta lactam antibiotic ciprofloxacin. *Pseudomonas* spp. isolated from blood showed 44% resistance to ceftazidime.

Thirty three percent resistance was observed each to ciprofloxacin, gentamicin and amikacin. Thirty percent of blood isolates were resistant to imipenem.

With regard to reserve group antibiotics namely colistin, four isolates from blood (0.5%), one from pus (0.1%), two from sterile body fluids (0.3%) and four from urine (0.4%) were found to be resistant.

Isolates from blood in Intensive care units, Inpatient wards and outpatient clinics of healthcare facilities showed high resistance to ceftazidime and aztreonam. Howeevr for carbapenems similar resistance was observed in *Pseudomonas* spp. isolated from inpatient wards, intensive care units. and outpatient clinics. (Fig. 10a)

Acinetobacter species

A total of 7,437 *Acinetobacter* species isolates were submitted by network sites of which 6,980 were from unique patients. Among all specimen types under the programme, *Acinetobacter* species was most commonly isolated from blood (24%) followed by sterile body fluids (23%), pus aspirate (9%) and the isolation rate from urine was 4%. (Table 1)

Acinetobacter isolated from blood showed 80% (CI: 71.8- 74.6) resistance to ceftazidime, similar high resistance was also observed in isolates from other specimen types namely pus aspirates 82% (CI:80.3-84.1), sterile body fluids 78% (CI: 75.3-81.1) and urine 65% (CI: 61.8-67.9). Imipenem showed 67% (CI: 64.9-68.4) resistance in blood isolates, similar resistance was seen in pus aspirates 68% (CI: 65.7-70.3) and sterile body fluids 71% (CI: 68.3-74.5) and lower resistance was observed in urine isolates 43%, (CI: 39.8-45.9).

Carbapenem resistance in blood isolates was found to be 67% which is comparatively lhigher thanin isolated from urine (43%). Resistance to colistin was observed to be 0.4% among blood and sterile body fluid isolates of *Acinetobacter* species, and 0.2% of the isolates from pus aspirates and urine were found to be resistant to colistin.

As compared to non-ICU settings, high resistance was observed in *Acinetobacter* species isolated from blood from ICU settings. Colistin resistance was found to be 0.6% in ICU setting and 0.4% in Inpatient setting. Notably Imipenem resistance was as high as 75% in isolates from ICU setting and 62% in inpatient settings. (Fig 8b)

Conclusion

Under the National Programme on AMR Containment, this bulletin includes aggregated data from 01 January to 30 June 2023 of 39 sentinel sites located across 30 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 39 sites this year. Quality of AMR surveillance data submitted by sites is ensured via continual capacity-building. Training based on standard operating procedures and other technical guidelines developed by NCDC have been held for data management, antimicrobial susceptibility testing, internal quality control (IQC).

Specific limitations that could affect data quality are availability of lab information system in many of the network sites, strict adherence to internal quality control SoPs, continuous supply of all antibiotic disks as per programme SoPs and quality management systems in place for automated ID and AST systems as recommended by the manufacturer.

To summarise, this bulletin on AMR data generated through AMR surveillance assists in monitoring antibiotic resistance trends for selected bacterial pathogens and enables effective public health interventions. Expanding the network to all states and Union Territories, along with continuous capacity building and quality assurance efforts, has improved the geographical representataion and reliability of the surveillance data. It is essential to leverage these findings to inform evidence-based interventions, policies, and programs that will mitigate the threat of AMR and preserve the effectiveness of antibiotics in India's healthcare system.

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