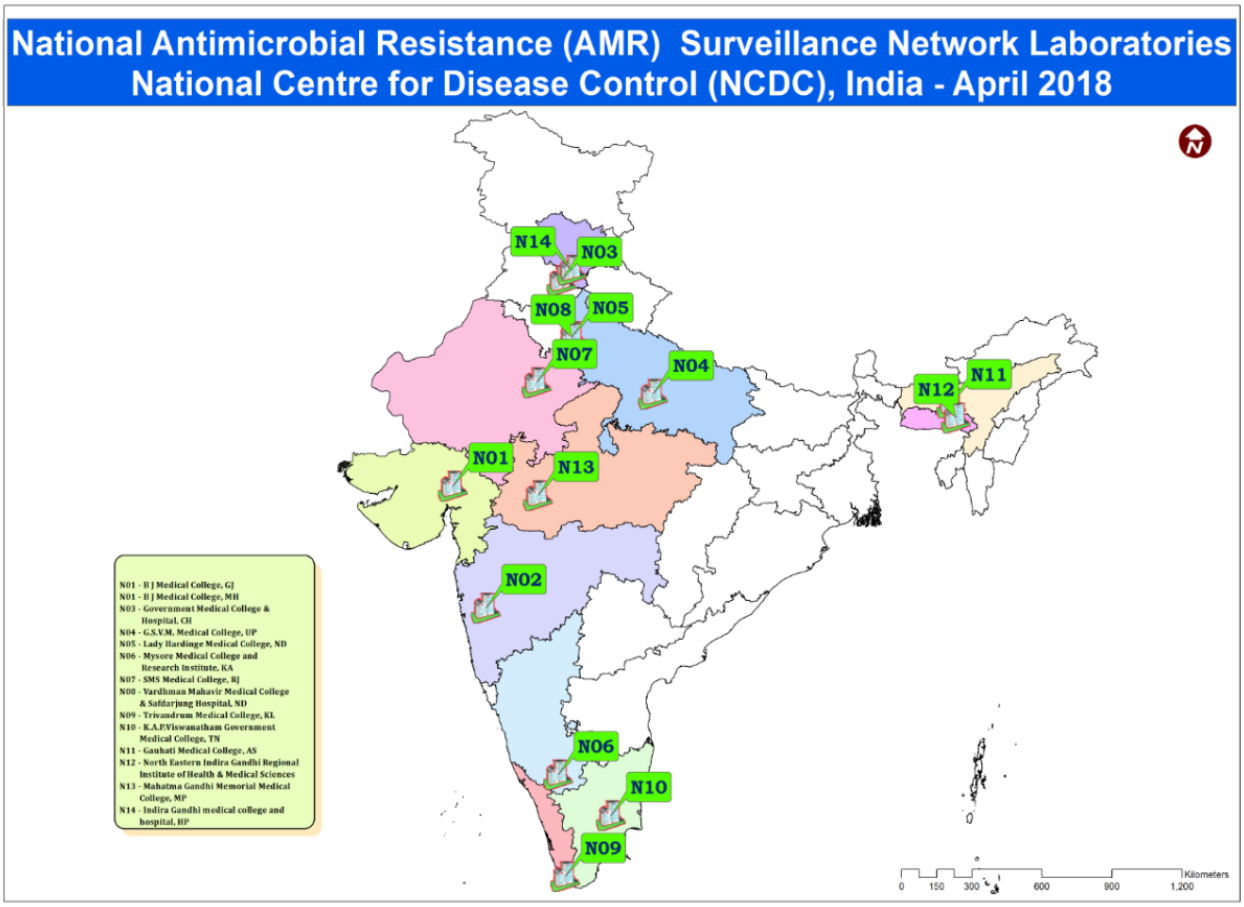
National Centre for Disease Control
National AMR Surveillance Network
AMR Data for year 2017

NCDC is coordinating the "National Programme for Containment of Antimicrobial resistance" approved during the 12th five year plan. Under the programme a network of laboratories is being set up across the country for conducting Antimicrobial Resistance (AMR) surveillance in order to understand the AMR trends in various geographical regions and accordingly take appropriate action. Currently 13 labs are included in the network:

1. Lady Hardinge Medical College and associated hospitals, New Delhi, Delhi
2. VMMC and associated Safdarjung Hospital, New Delhi, Delhi
3. Government Medical College & Hospital, Chandigarh (UT)
4. GSVM Medical College, Kanpur, Uttar Pradesh
5. SMS Medical College, Jaipur, Rajasthan
6. BJ Medical College, Ahmedabad, Gujarat
7. BJ Medical College, Pune, Maharashtra
8. Mysore Medical College and Research Institute, Mysore, Karnataka
9. KAPV Govt Medical College Hospital, Thiruchirapally, Tamil Nadu
10. Government Medical College, Thiruvananthapuram, Kerala
11. MGM Medical College & MY Hospital, Indore, Madhya Pradesh
12. NEIGRIHMS, Shillong, Meghalaya
13. Gauhati, Medical College Hospital, Guwahati, Assam

NCDC received AMR surveillance data for the year 2017 from 10 of the above 13 labs (S.no. 1 to 10) based on the standardized Data Management SOP in the WHONET format for the following pathogens:

1. *Staphylococcus aureus*
2. *Enterococci* species
3. *Escherichia coli*
4. *Klebsiella* species
5. *Pseudomonas* species
6. *Acinetobacter* species
7. *Salmonella enterica* serotype Typhi and Paratyphi



The AMR data collected under the National AMR Containment Programme for the year 2017 is from tertiary health care settings (medical colleges). The data has been analyzed and is summarized below:

Table1. The pathogens and specimens included

Specimen	*S. aureus*	*Enterococcus species*	*Klebsiella pneumoniae*	*E. coli*	*Acinetobacter species*	*Pseudomonas species*	*Salmonella* Typhi/Paratyphi
Blood	●	●	●	●	●	●	●
Urine		●	●	●			
Pus Aspirates	●	●	●	●	●	●	
Other Sterile Body fluids	●	●	●	●	●	●	

Total Number of unique patient's isolates data after validation from these 10 labs = 25833

- Urine - 12144
- Blood - 6354
- Pus Aspirates (PA) and Other Sterile body fluids (OSBF) - 7335

Figure 1. Isolation rate of priority pathogens from various specimens

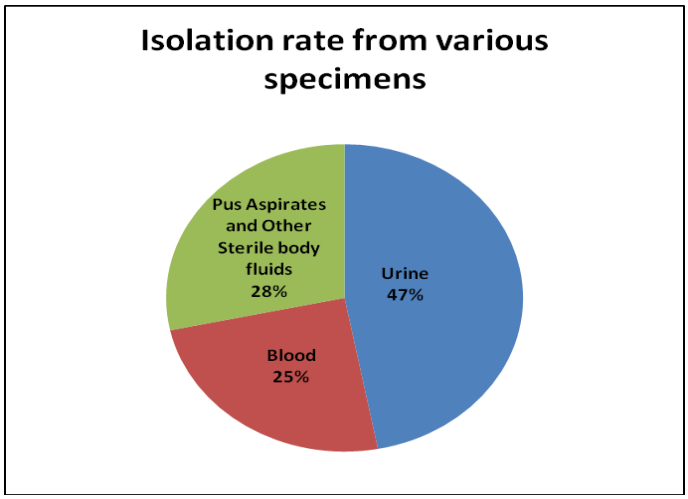
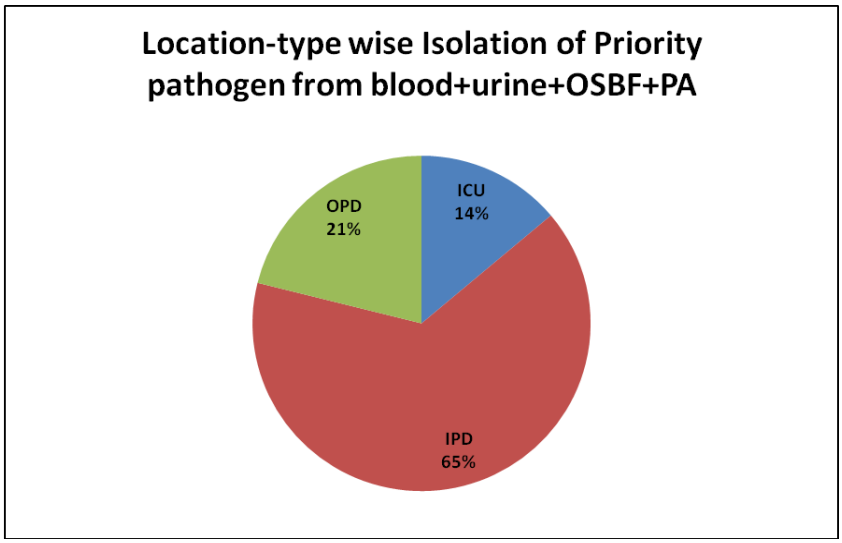


Figure 2. Isolation rate of priority pathogen from all specimens w.r.t the type of location in Healthcare facility

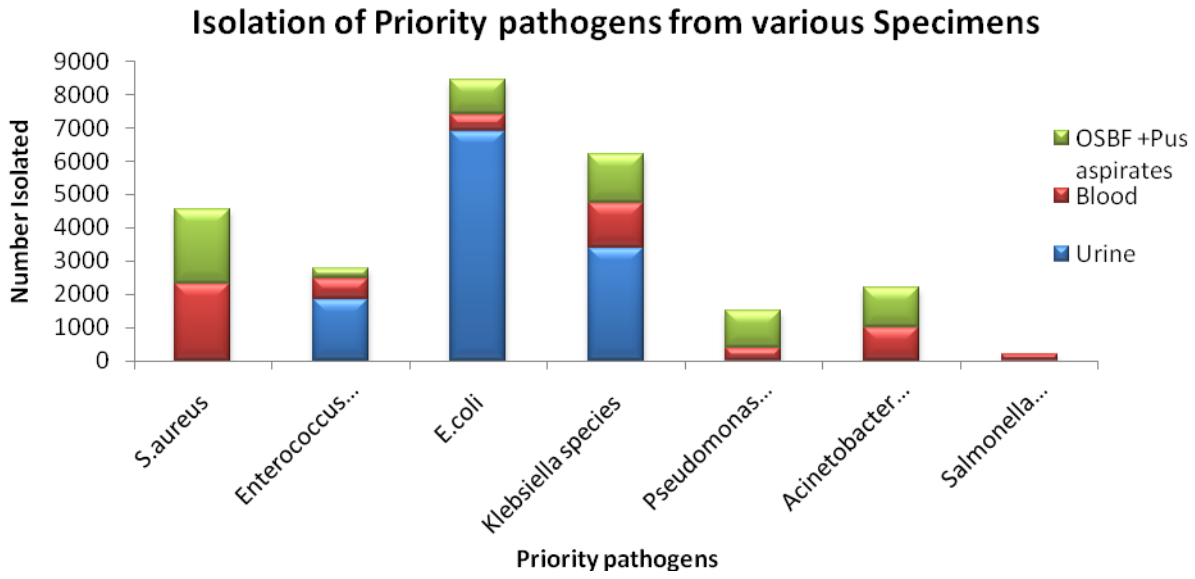


Of the 25833 isolates of priority pathogens, *E.coli* constituted 33% followed by *Klebsiella* species (24%), *S. aureus* (17.5%), *Enterococcus* species (10.6%), *Acinetobacter* species (8.5%) and *Pseudomonas* species (5.8%). However isolation rate from blood was highest for *S. aureus* (36.4%), followed by *Klebsiella* species (21.1%), *Acinetobacter* species (15.8%), *Enterococcus* species (9.7%), *E. coli* (7.8%) and lowest for *Pseudomonas* species (6%) (Table 2).

Table 2. Specimen-wise isolation of number of Priority Pathogens

Priority Pathogens	Total number of isolates	Number isolated from Blood	Number isolated from Urine	Number isolated Other Sterile Body Fluids +Pus aspirates
S. aureus	4537	2317	0	2220
***Enterococcus* species**	2760	620	1837	303
E. coli	8445	496	6919	1030
***Klebsiella* species**	6209	1341	3388	1480
***Pseudomonas* species**	1498	383	0	1115
***Acinetobacter* species**	2195	1008	0	1187
***Salmonella enterica* serotype Typhi and Paratyphi**	189	189	0	0
Total	**25833**	**6354**	**12144**	**7335**

Figure 3. Isolation of priority pathogens from various specimens



Antibiotic resistance pattern observed

The resistance profile of selected antibiotics as per NCDC AMR Surveillance SOP for priority pathogens have been tabulated in Tables 3-8 and summarized below:

Gram Positive Bacteria

S. aureus isolates from blood showed 57.1% resistance to cefoxitin (surrogate for *mec*A-mediated oxacillin resistance), overall resistance to cefoxitin including other sterile body fluids and pus aspirates was found to be 55.7% (Table 3 and 4). The results of resistance to vancomycin against *S. aureus* and *Enterococcus* species were not considered as the susceptibility test was not done by broth microdilution as per CLSI guidelines. However, emergence of linezolid resistant *S. aureus* isolates and isolates of *Enterococcus* species to the extent of 2.2% and 4.6% respectively is a matter of concern. Resistance to gentamicin (aminoglycoside) was observed to be 38.7% for *S. aureus* and 59% for *Enterococccus* species (Table 3 and 4). Figure 4 depicts the higher resistance rates for most of the antibiotics tested against *S. aureus* in ICU settings as compared to non-ICU setting. In contrast, the resistance rate for tetracycline and doxycycline was observed to be higher in non-ICU setting than in ICU setting (Figure 4 and 5).

Table 3: Resistance (%) in *Enterococcus species*

Antimicrobials tested	Blood+OSBF+PA+Urine (N=2760)		Blood+OSBF+PA (N=923)		Urine (N=1837)	
	No. tested	% Resistance	No. tested	% Resistance	No.tested	%Resistance
Ampicillin	1719	58.1	571	63	1170	55.8
Erythromycin	1206	72.3	590	73.1	631	71.8
Gentamicin (High)	2180	56.1	688	50.6	1514	59
Ciprofloxacin	1178	73.4	754	68.8	438	81.3
Linezolid	2459	5.7	754	8.6	1728	4.6
Tetracycline*	1068	44.9	359	43.5	722	45.7

Abbreviations: OSBF, Other sterile body fluids; PA, Pus aspirates

Figure 4. Resistance (%) in *Enterococcus* species w.r.t type of location in healthcare facility

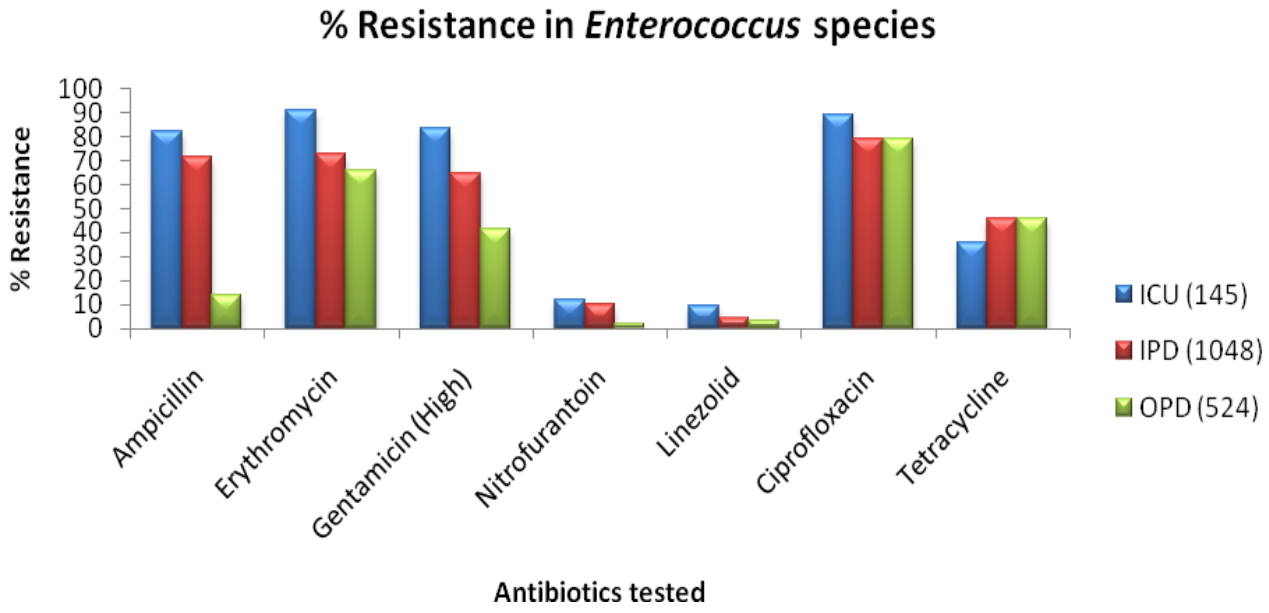


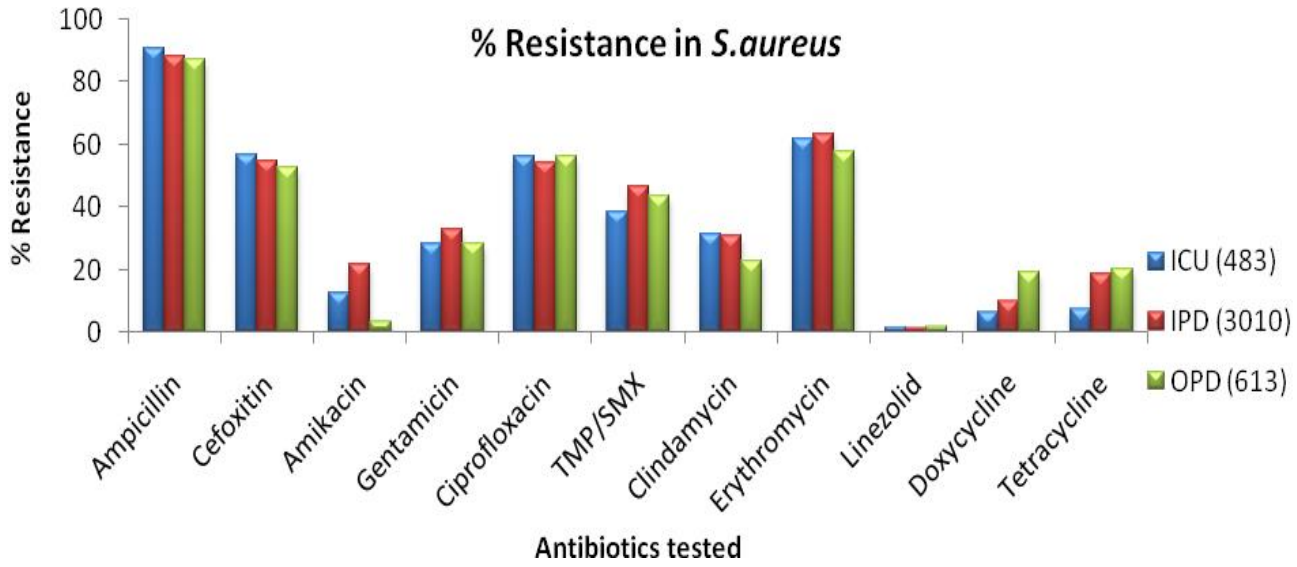
Table 4: Resistance (%) in *Staphylococcus aureus***

Antimicrobials tested	Blood+OSBF+PA (N=4537)		Blood (N=2317)		OSBF+PA (N=2220)	
	No. tested	% Resistance	No. tested	% Resistance	No. tested	% Resistance
Cefoxitin	3732	55.7	2159	57.1	1590	53.7
Erythromycin	3256	63.4	2180	62.9	1092	64.5
Clindamycin	2841	31.5	1857	32.7	999	29.4
TMP/SMX	2825	45.8	1423	46.2	1413	45.4
Gentamycin	3370	32	1834	26.3	1552	38.7
Ciprofloxacin	3259	55.9	2141	49.4	1134	68.3
Linezolid	3396	1.7	1885	1.3	1529	2.2
Doxycycline	695	11.1	418	7.9	282	15.6
Tetracycline	1546	19.5	918	14.2	633	27.2

Abbreviations: OSBF, Other sterile body fluids; PA, Pus aspirates;

****Sensitivity of *S. aureus* against vancomycin is not tested using screen agar test method therefore results are not considered.**

Figure 5: Resistance (%) in *Staphylococcus aureus* w.r.t type of location in healthcare facility



Gram Negative Lactose Fermenting Bacteria

E. coli isolated from blood showed 81.4% resistance to cefotaxime and 68.3% to cefepime. Similar trend was observed for urine isolates with resistance 79.3% to cefotaxime and 72.3% to cefepime. Resistance to carbapenems that is ertapenem and imipenem was observed to be 36.7% and 25.2% in blood isolates. While in urine isolates, slightly higher resistance was observed for imipenem (34%) than ertapenem (30.8%). In contrast to *E. coli*, isolates of *Klebsiella* species showed comparatively high resistance to carbapenems i.e. 43.5% to imipenem and 52.2% to ertapenem in blood isolates whereas 57.9% to imipenem and 55.8% to ertapenem in urine isolates. Similarly higher trend of resistance to cefotaxime and cefepime was observed in *Klebsiella* species isolated from blood and urine (Tables 5 and 6). Overall, blood isolates of *Klebsiella species* were more resistant than the *E. coli* isolated from blood (Figure 9).

Table 5: Resistance (%) in *Escherichia coli*

Antimicrobials tested	Blood+OSBF+PA+Urine (N=8445)		Blood (N=496)		Urine (N=6919)	
	No. tested	% Resistance	No. tested	% Resistance	No. tested	% Resistance
Ampicillin	3011	85.1	222	85.6	2338	84.3
Cefotaxime	5568	80.2	301	81.4	4755	79.3
Ceftazidime	2648	66	222	73	2054	62.3
Cefepime	2427	72.1	240	68.3	1926	72.3
Ertapenem	2846	30.9	251	36.7	2233	30.8
Imipenem	2147	30.5	349	25.2	1260	34
Ciprofloxacin	4312	73.2	453	58.1	3106	76.1

Abbreviations: OSBF, Other sterile body fluids; PA, Pus aspirates

Figure 6. Resistance (%) in *Escherichia coli* w.r.t type of location in healthcare facility

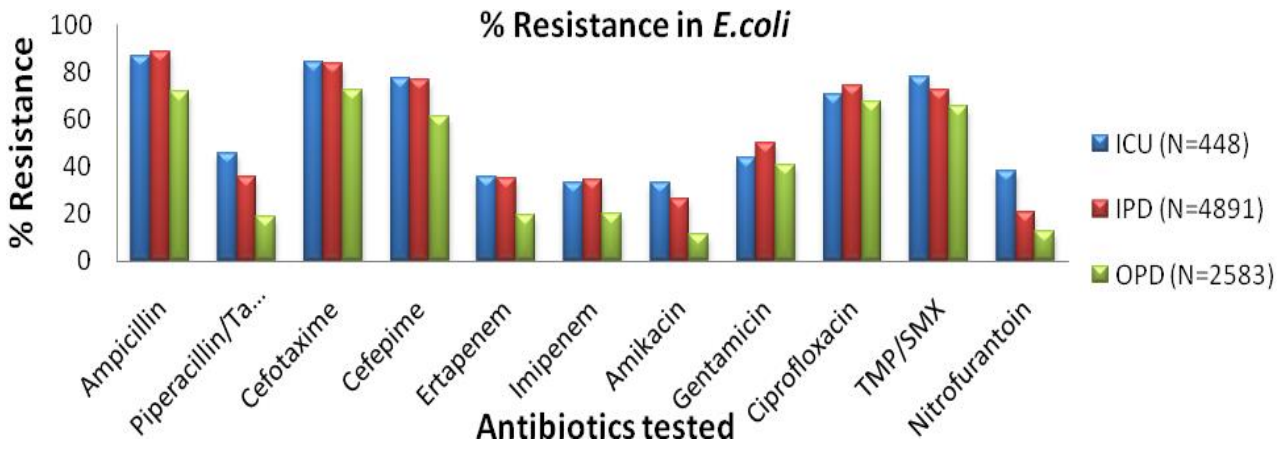


Figure 7. Resistance in *Escherichia coli* isolated from blood and urine in ICU (A) and IPD (B) healthcare facility

Figure7 (A)

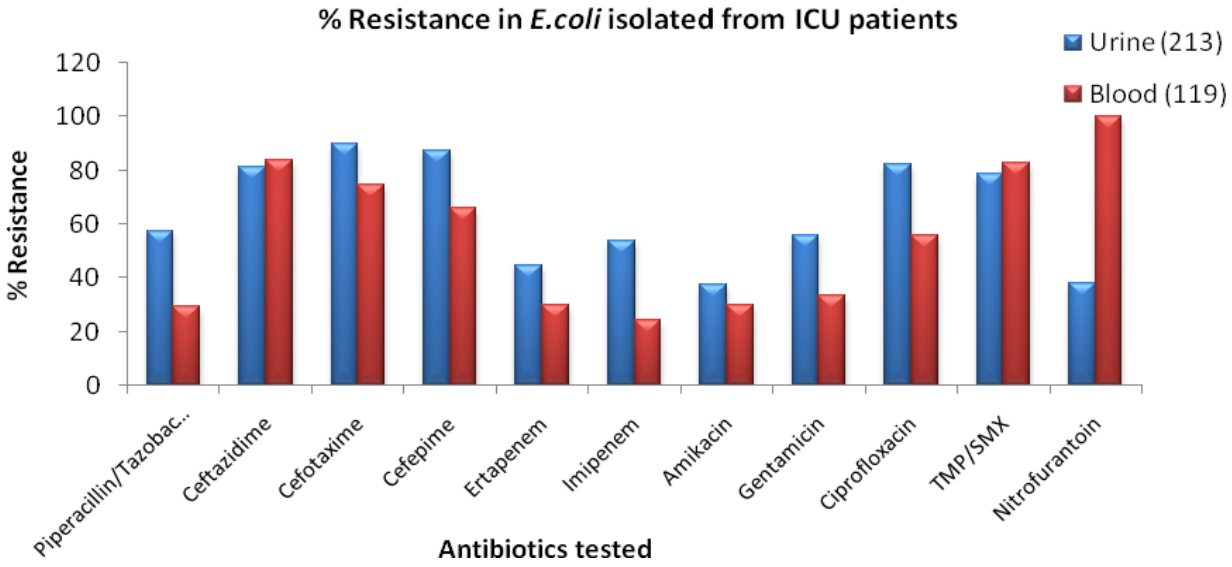


Figure 7(B)

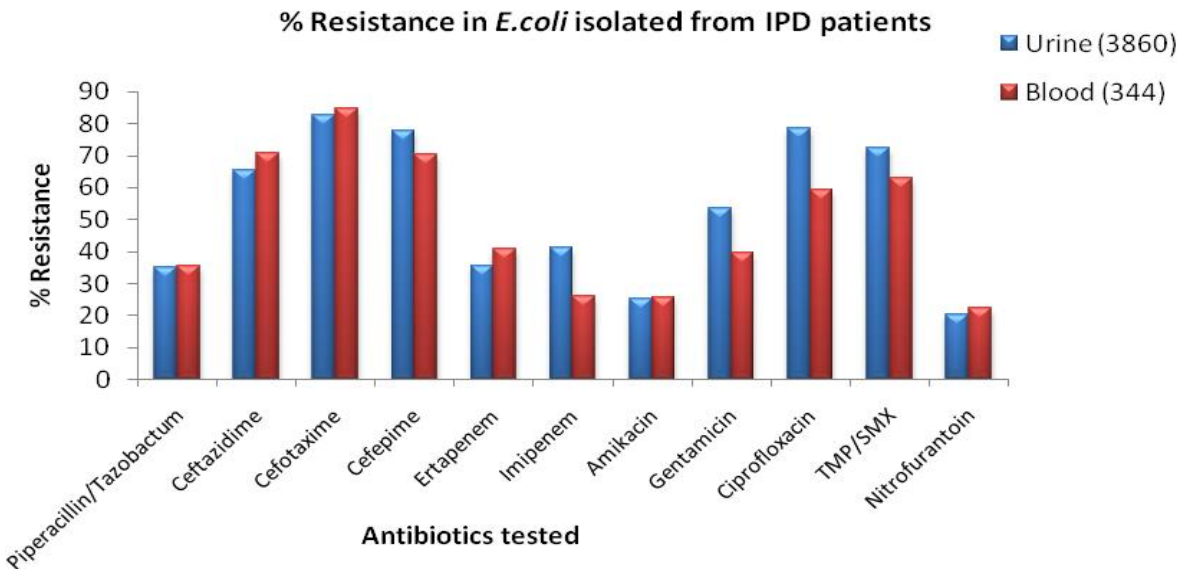


Table 6: Resistance (%) in *Klebsiella species*

Antimicrobials tested	Blood+OSBF+PA+Urine (N=6209)		Blood (N=1341)		Urine (N=3388)	
	No. tested	% Resistance	No. tested	% Resistance	No. tested	% Resistance
Cefotaxime	4371	82.8	971	90.2	2628	79.8
Ceftazidime	1437	68.7	378	84.1	577	49.7
Cefepime	2304	82.3	586	81.6	1264	84.3
Ertapenem	2969	53	734	52.2	1644	55.8
Imipenem	2365	48.4	749	43.5	822	57.9
Cipro	4039	65.2	1241	54.6	1624	74.7
TMP/SMX	4241	71.3	623	84.6	3148	68.6

Abbreviations: OSBF, Other sterile body fluids; PA, Pus aspirates; TMP/SMX (Trimethoprim/sulfamethoxazole or Cotrimoxazole)

Figure 8. Resistance (%) in *Klebsiella* species w.r.t type of location in healthcare facility

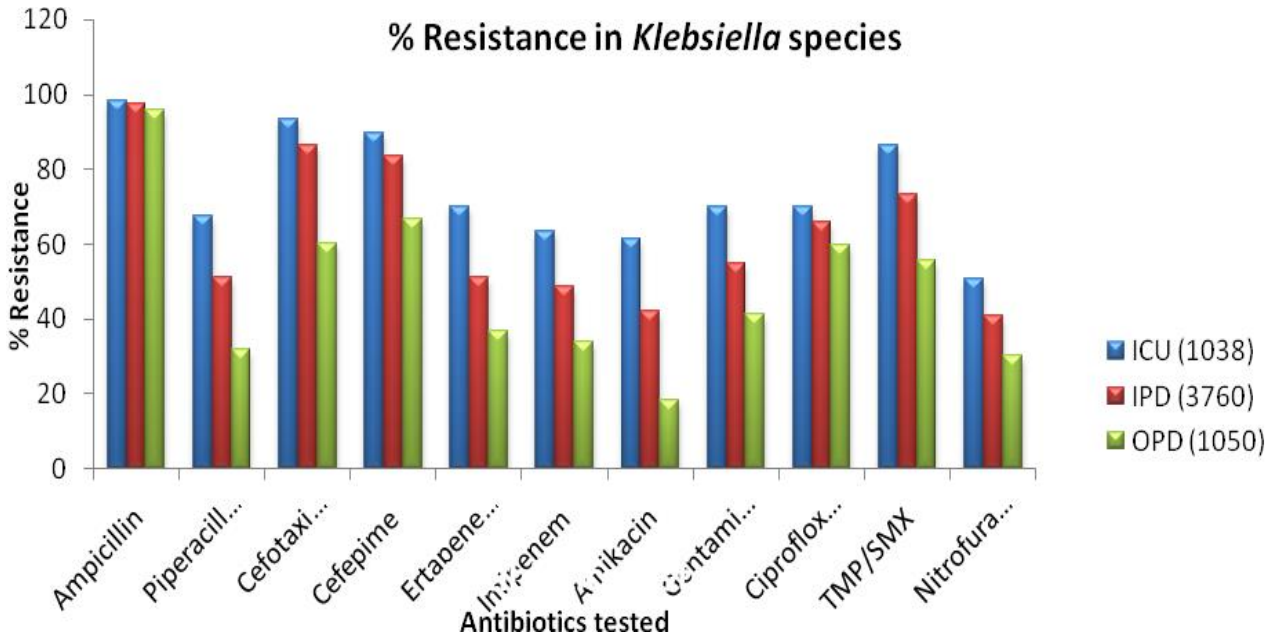


Figure 9. Resistance (%) in *Escherichia coli* and *Klebsiella* species isolated from blood (A) and urine (B) specimens

Figure 9(A)

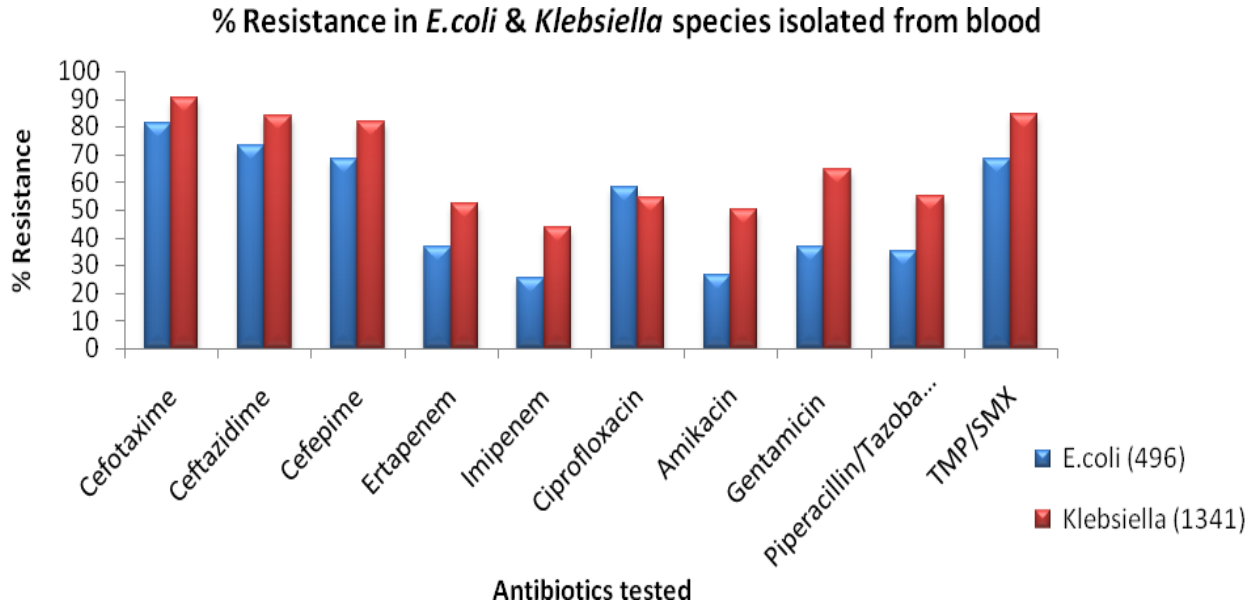


Figure 9(B).

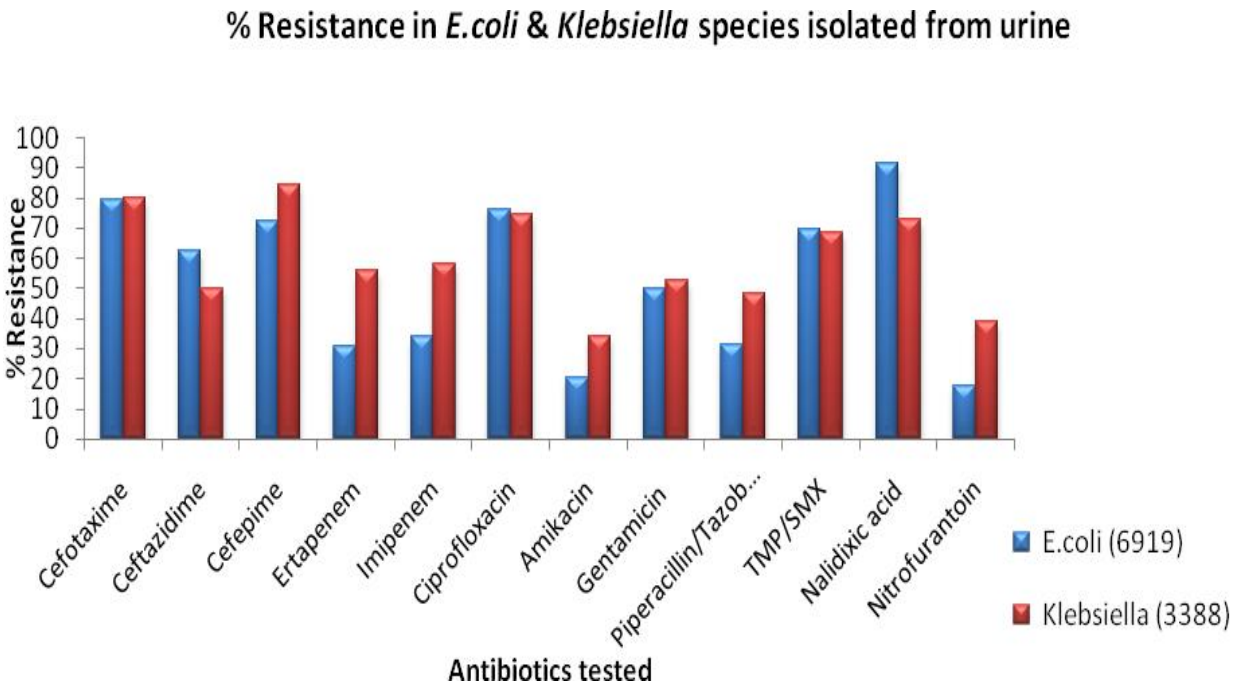


Figure 10. Resistance in *Klebsiella* species isolated from blood and urine in ICU (A) and IPD (B) healthcare facility

Figure 10 (A)

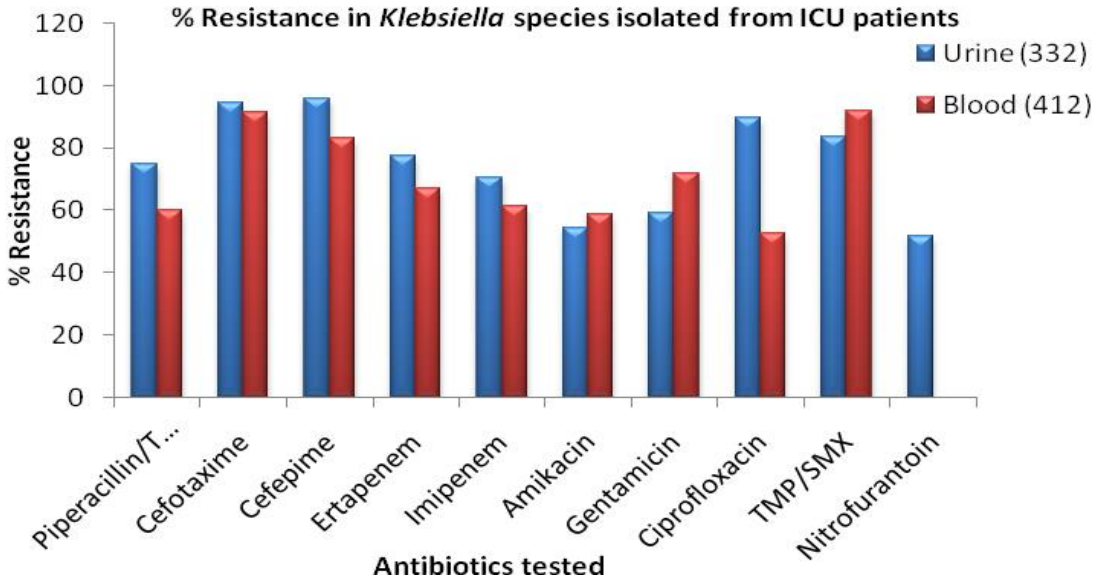
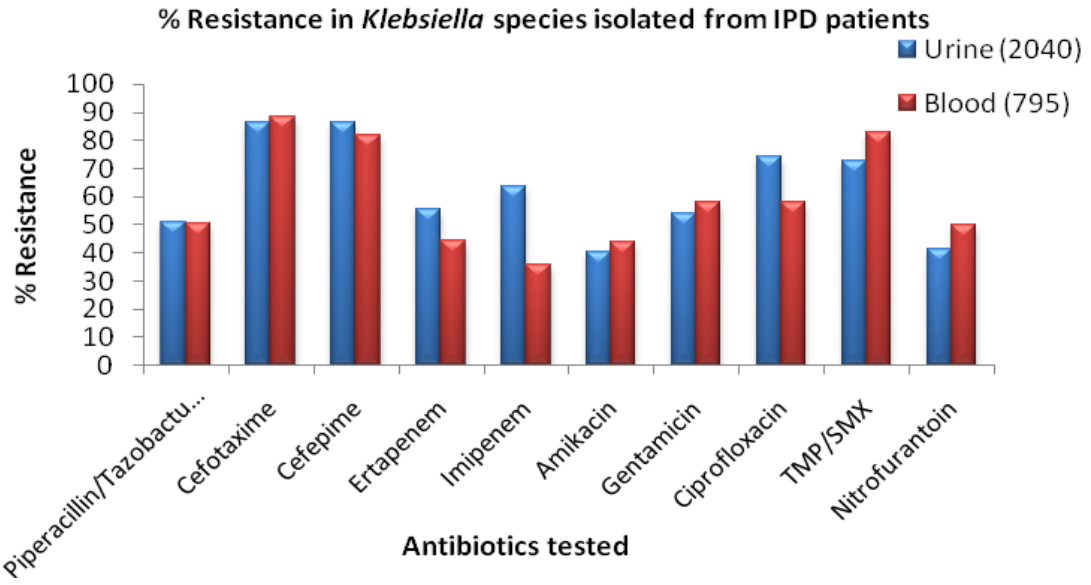


Figure 10 (B)



Gram Negative Non-Lactose Fermenting Bacteria

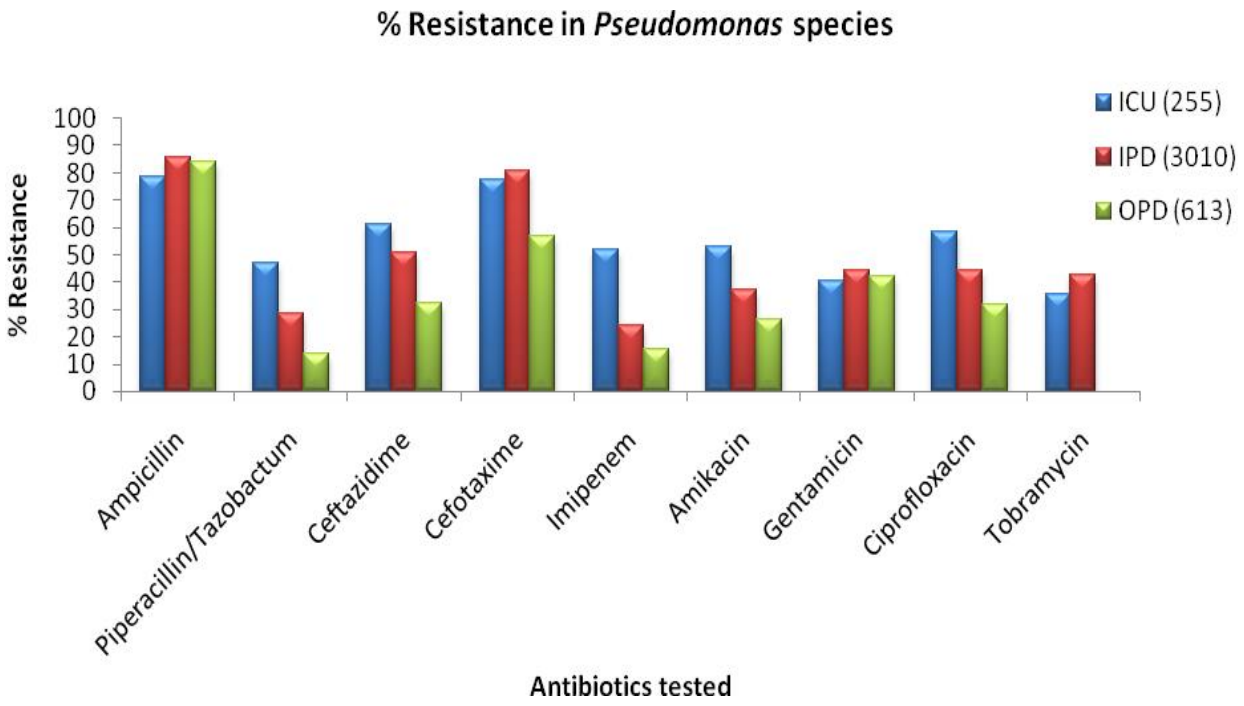
Overall resistance observed in *Pseudomonas* species was found to be lowest for Imipenem (29.9%) followed by piperacillin-tazobactam (31.6%), aminoglycosides (amikacin: 39.3%; tobramycin: 38.9%), ciprofloxacin (45.3%) and highest resistance was observed for ceftazidime (50%). In contrast *Acinetobacter* species showed an alarming % resistance to imipenem (66.1%). Almost similar pattern of resistance was observed for aminoglycosides (amikacin: 65.6%; gentamycin: 59.5%) (Tables 7 and 8). Among the anti-pseudomonal agents, imipenem and piperacillin/tazobactam showed comparable resistance rate 29.9% and 31.6% respectively. Notably, isolates from ICU showed higher resistance rates compared to isolates non-ICU settings (Figure 11).

Table 7: Resistance (%) in *Pseudomonas* species

Antimicrobials tested	Blood+OSBF+PA (N=1494)		Blood (N=383)		OSBF+PA (N=1115)	
	No. tested	% Resistance	No. tested	% Resistance	No. tested	% Resistance
Piperacillin-tazobactam	1144	31.6	304	23	842	34.9
Ceftazidime	1268	50.7	340	47.1	932	52.3
Imipenem	1168	29.9	311	30.2	861	30.1
Amikacin	1240	39.3	319	36.4	925	40.5
Tobramycin	265	38.9	76	30.3	190	42.6
Ciprofloxacin	1301	45.3	350	36	955	48.9

Abbreviations: OSBF, Other sterile body fluids; PA, Pus aspirates

Figure 11. Resistance (%) in *Pseudomonas* species w.r.t type of location in healthcare facility



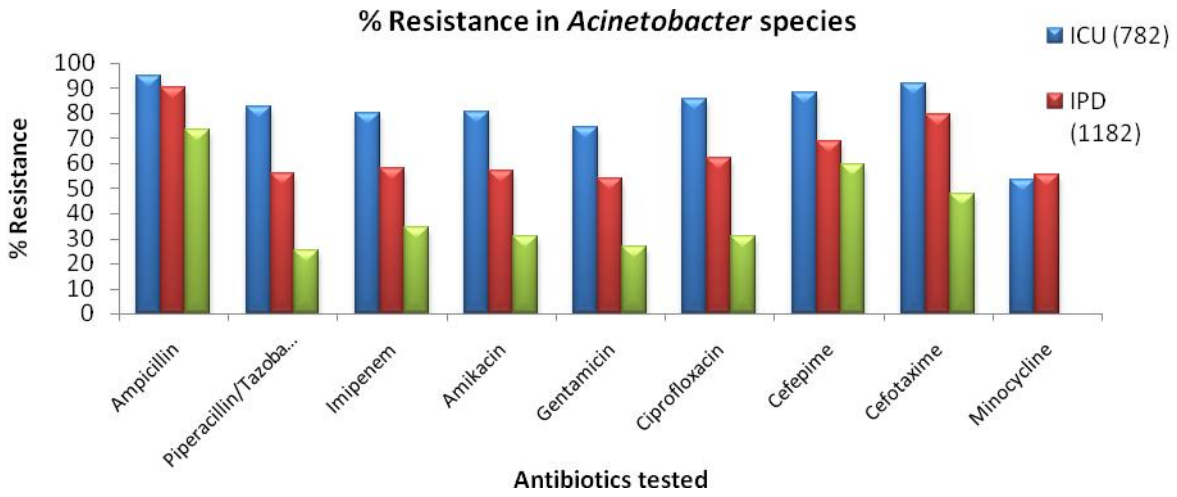
Isolates of *Acinetobacter* species showed >50% resistance to almost all the antibiotics tested. Among third generation cephalosporins, higher susceptibility was observed for ceftazidime than cefotaxime against both *Pseudomonas* species and *Acinetobacter* species. Among the ICU patients, antibiotics are administered empirically, therefore it is not surprising that the resistance rates against various antibiotics for *Acinetobacter* species are higher in the ICU setting as compared to ward and OPD (Figure 12).

Table 8: Resistance (%) in *Acinetobacter* species

Antimicrobials tested	Blood+OSBF+PA (N=2160)		Blood (N=1008)		OSBF+PA (N=1187)	
	No. tested	% Resistance	No. tested	% Resistance	No. tested	% Resistance
Imipenem	1677	66.1	825	58.3	886	73.9
Ceftazidime	1216	79.4	655	73.6	589	85.9
Cefotaxime	866	84.1	331	79.2	544	86.9
Amikacin	1828	65.6	881	57.8	980	73.2
Gentamycin	1045	59.5	509	51.1	545	67.5
Minocycline	268	53	137	54	134	52.2

Abbreviations: OSBF, Other sterile body fluids; PA, Pus aspirates

Figure 12. Resistance (%) in *Acinetobacter* species w.r.t type of location in healthcare facility



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Noticeably, isolates of *Salmonella enterica* serotype Typhi and Paratyphi obtained from blood showed 27.4% resistance to ciprofloxacin and *Salmonella* Typhi isolates showed 4.5% resistance to azithromycin (tested only for *Salmonella* Typhi) (Table 9).

Table 9: Resistance (%) in *Salmonella enterica* serotypes Typhi and Paratyphi isolated from blood

Antimicrobials tested	Blood (N=189)	
	No. tested	% Resistance
Ampicillin	157	18.5
Chloramphenicol	147	9.5
Ceftriaxone	176	0
Nalidixic acid	155	91.6
Ciprofloxacin	175	27.4
TMP/SMX	142	10.6
Azithromycin	89	4.5

Abbreviations: TMP/SMX (Trimethoprim/sulfamethoxazole or Cotrimoxazole)