Original Article

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Antimicrobial Sensitivity Pattern of Clinical Isolates in Intensive Care Unit in a Tertiary Care Hospital from Western India

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Abstract

Background: Patients in intensive care units (ICUs) are more prone to nosocomial infections caused by hospital strains of bacteria. These strains are often resistant to many antimicrobials.

Objective: The aim of this study was to determine the bacterial profile and their drug sensitivity and resistance in different clinical specimens in ICUs of a tertiary care hospital.

Materials and Methods: The study was conducted in different ICUs of a tertiary care teaching hospital in Western India, during April 2015 to March 2016. The clinical specimens received from ICUs were processed by standard method, bacteria were identified by VITEK 2 compact (biomerieux) automation system, and antimicrobial susceptibility testing was done with the same system to detect minimum inhibitory concentrations for penicillins, β-lactam/β-lactamase inhibitor, cephalosporins, carbapenems, aminoglycosides, tetracyclines, quinolones, folate inhibitors, nitrofurans, lipopeptides, and glycopeptides.

Results: A total of 1849 clinical isolates identified were included in the study. *Klebsiella* spp. (n = 466) followed by *Acinetobacter* spp. (n = 377), *Escherichia coli* (n = 368), and *Pseudomonas aeruginosa* (n = 311) were among the maximum isolates. Most bacterial isolates (n = 1305) were from medical intensive care units. Maximum isolates were from endotracheal tube (n = 650). Colistin, tigecycline, minocycline, imipenem, and meropenem were the most common sensitive drugs for Gram-negative organisms.

Conclusion: Optimum antimicrobial utilization in ICUs is important for better patient outcome and to prevent emergence of multidrug resistance. This can be achieved by strict infection control measures such as stringent adherence to hand washing practices, universal safety precautions, antibiotic policy formulation, and its implementation along with antibiotic stewardship program.

Key words: Antimicrobial sensitivity pattern, Clinical isolates, Intensive care units

INTRODUCTION

Patients in intensive care units are more prone to nosocomial infections caused by hospital strains of bacteria or opportunistic pathogens.[1] Because of extensive use of broad-spectrum antibiotics, these strains are often resistant to many antimicrobials.[2] Since there are differences in susceptibility patterns among hospitals, the hospital-wise antibiogram is useful for clinicians in the initial choice of antibiotics.[3]

Antimicrobial resistance pattern may also vary among individual hospital wards. If organisms isolated from patients in the intensive care units (ICUs) are more resistant but not in other hospital wards, this important information could be masked by the use of a hospital-wide antibiogram.[4] This is very important for the rational use of empirical therapy in critically ill patients.[5,6]

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There are very few published reports available on the microbial analysis of patient's samples and determination of antibacterial susceptibility patterns in this region from ICUs. Such data could be beneficial for the use of appropriate antimicrobials, reducing the duration of stay in the hospital, and also reducing the morbidity and mortality rate.[4,5] Furthermore, findings of such regional studies can be useful region wise or state wise, which may be helpful for preparing antibiotic policy.

MATERIALS AND METHODS

Study Design

This was a laboratory based prospective study.

Study Period

The study took place from April 2015 to March 2016.

Settings

The study was carried out at the Department of Microbiology, Krishna Institute of Medical Sciences, Karad.

Inclusion Criteria

Clinical isolates isolated from different ICUs from clinical specimens were included in the study.

Exclusion Criteria

Repeat isolates from the same patient from repeat specimen were excluded from the study to avoid duplication of isolate.

METHODOLOGY

The clinical specimens received from ICUs in this period were included. Different ICUs were medicine intensive care unit (MICU), pediatric intensive care unit (PICU), cardiac intensive care unit (CICU), and surgery intensive care unit (SICU). Specimens included were pus, endotracheal secretions, sputum, urine, stool, cerebrospinal fluid, blood, and body fluids such as ascitic fluid, peritoneal fluid, pleural fluid, and other specimens such as catheter tips, knee aspirate, and corneal scrapings. Processing of the specimens was done on blood agar, chocolate agar, and Mac Conkey's agar.[7] Bacterial colonies were identified by VITEK 2 compact (biomerieux) automation system and antimicrobial susceptibility testing was done with the same system to detect minimum inhibitory concentrations.[8] For this, antimicrobials used in the panel were amikacin, ceftazidime, ciprofloxacin, ceftriaxone, colistin, cefazolin, cefepime, nitrofurantoin, gentamicin, imipenem, levofloxacin, meropenem, piperacillin, ampicillin/sulbactam, trimethoprim/sulfamethoxazole, tigecycline, ticarcillin, piperacillin/tazobactam, cefoperazone/sulbactam, tetracycline, ticarcillin, piperacillin/tazobactam, and vancomycin.

Interpretation of the test was done as per the Clinical and Laboratory Standards Institute (2015) guidelines.[9] Quality control of the test was done by standard ATCC strain *Escherichia coli* 25922, *Pseudomonas aeruginosa* 27853, and *Staphylococcus aureus* 29213.[9,10] Results of all the isolated strains, isolated during study period, were included for data analysis in the study. For this, MS Excel software was used.

RESULTS

A total of 1849 clinical isolates identified during the study period were included in the study project. Bacterial distribution was as shown in Table 1 with the highest being *Klebsiella* spp. (n = 466). This was followed by *Acinetobacter* spp. (n = 377), *E. coli* (n = 368), *P. aeruginosa* (n = 311), and *S. aureus* (n = 249) with the least isolated being *Salmonella* spp. (n = 2).

Most bacterial isolates (n = 1305) were from MICU, which contributed to 70.57% of the total isolates with minimum isolates were from PICU (1.89 %) (Table 2).

Maximum isolates (Figure 1) were from endotracheal tube (ETT) (n = 650), followed by urine (n = 558), sputum

Table 1: Distribution of bacteria among clinical isolates

Bacteria	Frequency (n)
Klebsiella spp.	446
Acinetobacter spp.	377
E. coli	368
P. aeruginosa	311
S. aureus	249
Enterobacter spp.	30
Enterococcus spp.	27
Proteus spp.	27
Citrobacter spp.	6
Serratia spp.	6
Salmonella spp.	2
Total	1849

E. coli: Escherichia coli, P. aeruginosa: Pseudomonas aeruginosa, S. aureus: Staphylococcus aureus

Table 2: Distribution of clinical isolates among ICU

ICU name	Frequency (%)
MICU	1305 (70.57)
CICU	84 (4.54)
PICU	35 (1.89)
SICU	425 (22.98)
Total	1849 (100)

ICU: Intensive care units, MICU: Medicine ICU, CICU: Cardiac ICU, PICU: Pediatric ICU, SICU: Surgery ICU

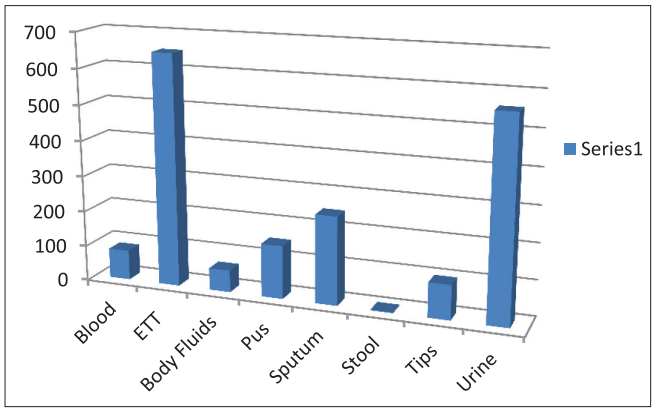

Figure 1: Number of clinical isolates in different clinical specimens

(*n* = 247), and pus (*n* = 149). The two *Salmonella* spp. were isolated from stool specimens.

Table 3 shows the distribution of clinical isolates in different clinical specimens. Of the different species, *Klebsiella* spp. (*n* = 173), *Acinetobacter* spp. (*n* = 207), and *P. aeruginosa* (*n* = 135) were isolated from ETT-related specimens. Maximum *E. coli* (*n* = 189), *S. aureus* (*n* = 63), *Enterococcus* spp. (*n* = 23), and *Proteus* spp. (*n* = 19) were isolated from urine.

Antimicrobial sensitivity pattern of the different major bacterial isolates to different antimicrobials was shown in Table 4. Major number of Gram-negative isolates

Table 3: Distribution of clinical isolates in different clinical specimens

Specimen	*Klebsiella* spp.	*Acinetobacter* spp.	*E. coli*	*P. aeruginosa*	*S.aureus*	*Enterobacter* spp.	*Enterococcus* spp.	*Proteus* spp.	*Citrobacter* spp.	*Serratia* spp.	*Salmonella* spp.
Blood	7	13	14	3	37	9	1	0	0	0	0
ETT	173	207	68	135	52	6	2	4	2	1	0
Body fluids	11	19	17	9	2	3	0	1	0	0	0
Pus	28	25	34	21	34	0	0	3	1	3	0
Sputum	68	62	28	54	31	3	0	0	1	0	0
Stool	0	0	0	0	0	0	0	0	0	0	2
Tips	23	12	18	11	30	1	1	0	0	1	2
Urine	136	39	189	78	63	8	23	19	2	1	0
Total	446	377	368	311	249	30	27	27	6	6	2

ETT: Endotracheal tube, *E. coli: Escherichia coli, P. aeruginosa: Pseudomonas aeruginosa, S. aureus: Staphylococcus aureus*

Table 4: Antimicrobial sensitivity pattern of clinical isolates to different antimicrobials

Bacteria	*E. coli* (*n*)		*Klebsiella* spp. (*n*)		*Acinetobacter* spp. (*n*)		*P. aeruginosa* (*n*)		*S. aureus* (*n*)		*Enterobacter* spp. (*n*)		*Enterococcus* spp. (*n*)	
Antimicrobials	**S**	**R**	**S**	**R**	**S**	**R**	**S**	**R**	**S**	**R**	**S**	**R**	**S**	**R**
Amoxicillin/clavulanic	74	209	65	287	13	79	5	8	0	0	1	8	0	0
Amikacin	287	77	284	141	77	118	137	161	2	4	16	11	0	0
Ceftazidime	10	34	4	35	27	250	86	191	0	5	7	11	0	0
Ciprofloxacin	51	310	88	335	48	325	101	195	40	208	19	10	1	24
Ceftriaxone	30	291	32	374	3	82	3	12	0	1	4	8	0	0
Colistin	356	11	431	14	350	24	224	65	4	2	28	2	0	0
Cefuroxime	24	290	20	381	2	88	2	13	0	1	2	9	0	0
Ertapenem	184	124	148	249	0	0	0	0	0	1	4	8	0	0
Cefepime	97	223	97	321	46	325	109	167	0	6	11	17	0	0
Nitrofurantoin	182	90	119	202	5	84	2	9	213	16	2	3	9	8
Gentamicin	171	191	144	288	76	284	126	173	125	106	14	16	0	0
Imipenem	263	99	200	211	57	316	119	187	1	5	13	16	0	0
Levofloxacin	4	40	5	32	34	187	78	200	38	212	12	6	1	24
Meropenem	240	124	165	278	52	321	115	178	0	6	14	16	0	0
Minocycline	26	17	15	16	212	26	55	192	2	3	10	5	0	0
Nalidixic acid	30	292	79	327	14	79	2	13	1	0	8	4	0	0
Cefoperazone/sulbacta	178	138	142	260	87	210	109	150	3	3	14	15	0	0
Trimethoprim/sulfa.	106	260	167	278	90	285	36	271	106	150	12	18	0	0
Ticarcillin/clavulanic	0	0	0	0	0	0	29	150	0	0	0	0	0	0
Tigecycline	336	15	330	55	319	9	50	227	231	1	26	4	24	0
Piperacillin/tazobactam	117	221	68	354	36	328	72	191	0	4	10	17	0	0
Vancomycin	0	0	0	0	0	0	0	0	192	41	0	0	22	3

n: Number, S: Sensitive strains, R: Resistant strains, *E. coli: Escherichia coli, P. aeruginosa: Pseudomonas aeruginosa, S. aureus: Staphylococcus aureus*

were resistant to β-lactam antimicrobials and β-lactam/β-lactamase inhibitor combination. Resistance was also shown to quinolone and to some extent carbapenem group.

What was alarming was 41 (17.59%) strains of *S. aureus* were resistant to vancomycin. Similarly, vancomycin-resistant *enterococci* were 12% ($n = 3$) (Table 4).

Colistin, tigecycline, minocycline, imipenem, and meropenem were the most common sensitive drugs for *E. coli*, *Klebsiella* spp. *Acinetobacter* spp., and *P. aeruginosa* (Figures 2-5). Nearly, 78.85% and 66.91% of *E. coli* were sensitive to amikacin and nitrofurantoin, respectively (Figure 2). *Klebsiella* spp. showed only 48.66% sensitivity to imipenem (Figure 3). Except tigecycline, colistin, and minocycline, all other antimicrobials showed <40% sensitivity for *Acinetobacter* spp. (Figure 4).

P. aeruginosa showed 66.66% and 39.25% sensitivity to ciprofloxacin and meropenem, respectively (Figure 5).

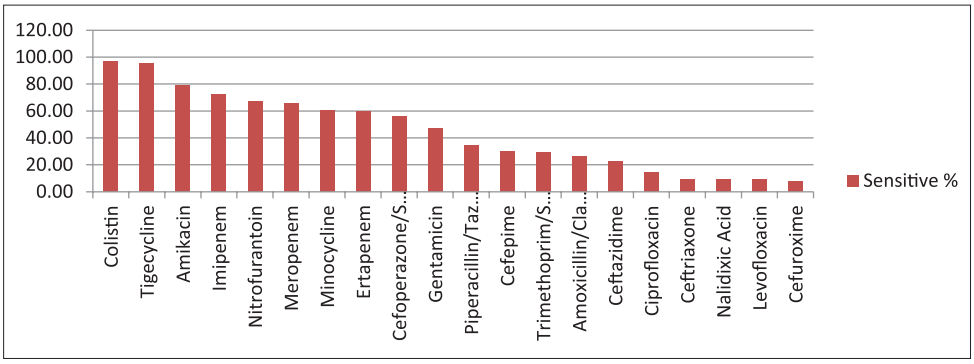

Figure 2: *Escherichia coli* antimicrobial sensitivity pattern (%)

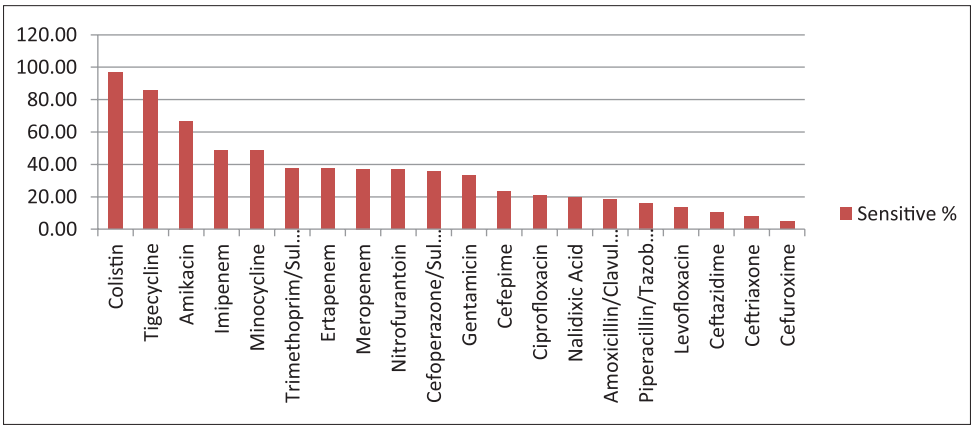

Figure 3: *Klebsiella* spp. antimicrobial sensitivity pattern (%)

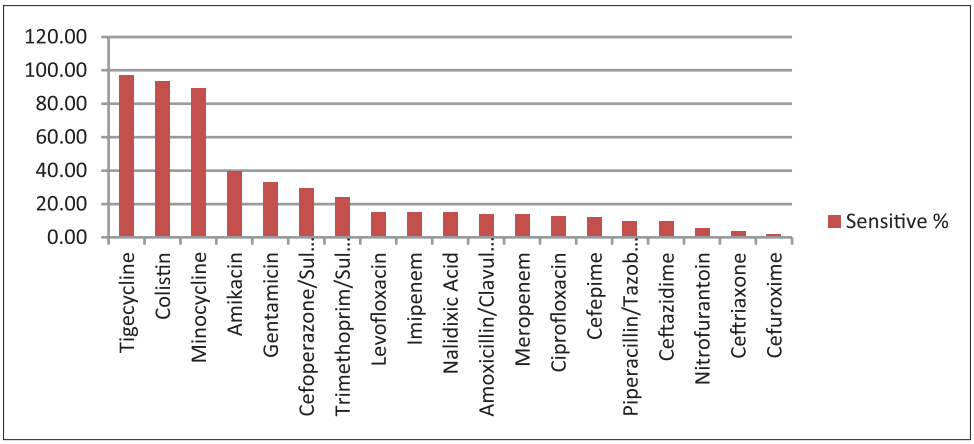

Figure 4: *Acinetobacter* spp. antimicrobial sensitivity pattern (%)

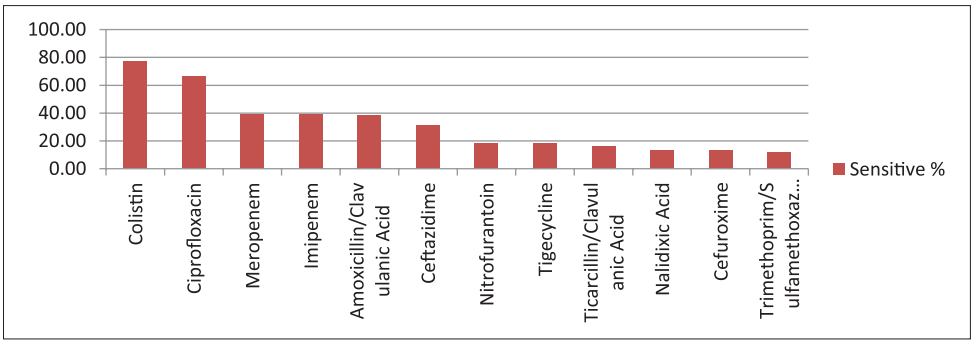

Figure 5: *Pseudomonas aeruginosa* antimicrobial sensitivity pattern (%)

DISCUSSION

The most important goal for any ICUs should be reduction in antimicrobial resistance.[11] This will ensure better patient outcome and will reduce the cost of antibiotics and also patient's duration of ICUs stay.[11] For this, it is important to have knowledge of bacterial profile and antibiogram of particular ICUs in any hospital.

In the present study, *Klebsiella* spp. followed by *Acinetobacter* spp. was the most frequently isolated organism. This is correlating with the type of clinical specimens with the main source being respiratory tract that is ETT and sputum. Similar findings were observed by Hanberger *et al.*[12] Ventilator-associated pneumonia is the most frequent ICU's infection.[13] Up to 40% of these can be polymicrobial.[13] This explains that most frequent number of clinical isolates in the present study were from MICU compared to SICU and CICU, as that of carried out by Javeri *et al.*[14]

High level of resistance was observed to cephalosporin group. Antimicrobials such as cefepime, ceftazidime, ceftriaxone, and cefazolin showed >40% of sensitivity. This might be due to the widespread use of cephalosporins. Similar findings with higher percentage of sensitivity was observed by Singh *et al.*[15] Combination drugs such as beta lactam and beta lactamase inhibitor may be useful to some extent, but the sensitivity to these drugs in the present study is causing worrisome in the present therapeutic scenario. In fact, studies have shown high prevalence resistance among Gram-negative bacteria as compared to Gram-positive bacteria in India.[16]

Quinolones in the present study showed a high degree of resistance as compared to carbapenem group. Similar findings were observed by Singh *et al.*[15]

Colistin, tigecycline, minocycline, amikacin, imipenem, and meropenem were the most common sensitive drug for Gram-negative clinical isolates, ranging from 45% to 97% of sensitivity. Studies conducted in India have shown more percentage of sensitivity for this antibiotics.[14-17]

Colistin has its own limitations because of its toxicity. Tigecycline and minocycline are showing higher sensitivity in this region because of its no use or very limited use. This signifies the rotational use of antimicrobials to improve sensitivity. Also, the use of carbapenem group for treatment has resulted in decline in sensitivity to these antibiotics compared to other studies.[14, 15]

Among Gram-positive cocci, *S. aureus* showed more sensitivity to vancomycin, trimethoprim, sulfamethoxazole, nitrofurantoin, and least sensitivity to penicillin and quinolone groups. Regular surveillance of antimicrobial sensitivity pattern is important for guiding clinicians in the therapy of infected patients.[18]

CONCLUSION

Amikacin and carbapenem groups were the most useful antimicrobials in ICUs infections in present study. Cephalosporin group showed the maximum resistance, with limitation in treatment. Although colistin was most effective against all Gram-negative organisms, its use should be monitored considering its toxicity.

Optimum antimicrobial utilization in ICUs is important for better patient outcome and to prevent emergence of multidrug resistance. This can be achieved by strict infection control measures such as stringent adherence to hand washing practices,[14,15] universal safety precautions, antibiotic policy formulation, and its implementation,[14] following antimicrobial stewardship program with rotational, restricted, and combinational use of antimicrobials.

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