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To Study the Prevalence and Pattern of Resistance and Sensitivity of Commonly Isolated Organisms in Patients Admitted In Surgical Intensive Care

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Abstract:

Introduction: *Nosocomial infections effect more than 2 million patients annually at a cost of US 4.5 billion. Intensive care units (ICU's) patients are more vulnerable for development of these infections compared with an average patient. This study was conducted to know the prevalence and pattern of resistance and sensitivity of commonly isolated organisms in patients admitted in ICU's of a tertiary care hospital.*

Material and methods: *The patients developing ICU infections within 48 hours of admission in ICU or within 48 hours of transfer from ICU were included. Depending upon the clinical suspension Laboratory samples like urine, pus, blood, endotracheal suction catheter samples and central line tip culture samples were collected. The samples collected from ICU unit were inoculated on 5% sheep blood agar and MacConkey agar plates and incubated overnight at 37^0C aerobically. Bacterial pathogens were identified by Conventional Biochemical methods according to standard microbial techniques.*

Results: *Forty patients with mean age of 51.43 ± 12.87 years showing different types of infections were included in this study. 92 samples including blood, urine, swab, sputum, pus and ETT samples were collected. A total of 10 types of micro-organisms were isolated with maximum number of micro-organisms were isolated from swab. Further, among ten micro-organisms isolated, the highest percentage was recorded for Pseudomonas spp. A total of 17 antibiotics were used to workout the sensitivity/resistance pattern of various micro-organisms. Among the various antibiotics used, imipenem, amikacin, nitrofurantoin, gentamicin, pipracillin-tazobactam and ceftazidime were found highly sensitive to most of the micro-organisms isolated.*

Conclusion: *Most of the Gram negative isolates were multiply resistant to commonly prescribed antimicrobial agents. Hence, for proper management of critically ill patients in ICUs, hospital antibiotic policies need frequent revisions.*

Keywords: *Antibiotics, infection, cultures.*

Introduction

The emergence of organisms that are resistant to all the antibiotics usually used against them is alarming. Antibiotic resistant bacterial nosocomial infections are a leading problem in intensive care units (ICU's). The pattern of organisms causing infections and their antibiotic resistance pattern vary widely from one country to another as well as from one hospital to another and even ICU's within a hospital.[1] It is therefore important to know the local antibiotic resistant pattern as they may differ from other settings and is required to inform, appropriate local antibiotic use. Therefore, present study was aimed to know the prevalence and pattern of resistance and sensitivity of commonly isolated organisms in patients admitted in ICU's of a tertiary care hospital in J&K, India.

Materials and Methods

The study was conducted in surgical intensive care unit (ICU) of a Tertiary Care Hospital in Jammu and Kashmir (India) from March 2015 to March 2016. The patients developing ICU infections within 48 hours of admission in ICU or within 48 hours of transfer from ICU were included.

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However, patients showing clinical signs of infection on or prior to admission or transfer to ICU were ignored. Depending upon the clinical suspension Laboratory samples like urine, pus, blood, endotracheal suction catheter samples and central line tip culture samples were collected. The samples collected from ICU unit were inoculated on 5% sheep blood agar and MacConkey agar plates and incubated overnight at 37^0C aerobically. Bacterial pathogens were identified by Conventional Biochemical methods according to standard microbial techniques.[2] *Pseudomonas aeruginosa* were identified by colonial morphology, a positive oxidase reaction, pyocyanin production, motility colonies which displayed a positive oxidase test was further subjected to biochemical reactions. Antimicrobial sensitivity was performed on Muellar-Hinton agar (Hi-Media India) by Kirby-Bauer disk diffusion method as per National Committee for Clinical Laboratory Standards.[3] The routine antibiotic sensitivity tests were put up for the carbapenem resistance when the zone of inhibition around Imipenem disc was ≤13mm. Sensitivity was also investigated for Amikacin, Gentamicin, Tobramycin, Ceftazidime, Cefotaxime, Ciprofloxacin, Chloramphenicol, Norfloxacin, Cefoperazone, Sulbactam and Piperacillin.

The results obtained were statistically expressed as mean and standard deviation.

Observations and Results

The data presented in Table 1 exhibited the age, sex distribution and admission of patients to ICU.

Table 1: Age, sex distribution and admission of patients to ICU

Age groups (years)	**No. of patients**	**Percentage**
≤30	3	7.5
31-40	6	15.0
41-50	10	25.0
51-60	13	32.5
61-70	6	15.0
<70	2	5.0
Mean age ± SD	**51.43 ± 12.87**	
Sex distribution	**No. of patients**	**Percentage**
Male	26	65.0
Female	14	35.0
Admission	**No. of patients**	**Percentage**
Direct	25	62.5
Transferred	15	37.5

Perusal of the Table 2 revealed that 92 samples were collected from these 40 admitted patients in which 39.13% were blood samples, 27.17%, 8.70%, 7.61%, 10.87% and 6.52% were urine, swab, sputum, pus and ETT samples, respectively.

Table 2: Sample profile and rate of positive cultures

Samples	**No. of samples**		**Samples yielding growth of micro-organisms**	
	No.	**Percentage**	**No.**	**Percentage**
Blood	36	39.13	10	27.78
Urine	25	27.17	19	76.00
Swab	8	8.70	7	87.50
Sputum	7	7.61	5	71.43
Pus	10	10.87	8	80.00
ETT	6	6.52	2	33.33
Total	**92**	**-**	**53**	**-**

Table 3 depicts the pattern of organisms isolated from different samples. Perusal of the table revealed that 10 types of micro-organisms were isolated (*E.coli*, *Pseudomonas* spp., *Klebsiella* spp., *Acinetobacter* spp., *Staphy aureus*, *Enterococcus*, *Enterobacter* spp., *Proteus* spp., *Citrobacter* spp. and *Candida* spp.) from six types of samples viz., blood, urine, swab, sputum, pus and ETT.

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Table 3: Pattern of organisms isolated from different samples

Organism	Samples (%)						Total (%)
	Blood	Urine	Swab	Sputum	Pus	ETT	
E.coli	3 (13.64)	4 (21.05)	3 (10.00)	2 (12.50)	4 (28.57)	3 (25.00)	19 (16.81)
Pseudomonas spp.	8 (36.36)	6 (31.58)	9 (30.00)	6 (37.50)	4 (28.57)	2 (16.67)	35 (30.97)
Klebsiella spp.	5 (22.73)	5 (26.32)	11 (36.67)	5 (31.25)	2 (14.29)	1 (8.33)	29 (25.66)
Acinetobacter spp.	1 (4.55)	0 (0.00)	1 (3.33)	0 (0.00)	2 (14.29)	6 (50.00)	10 (8.85)
Staphy aureus	1 (4.55)	1 (5.26)	1 (3.33)	0 (0.00)	1 (7.14)	0 (0.00)	4 (3.54)
Enterococcus	1 (4.55)	1 (5.26)	2 (6.67)	0 (0.00)	1 (7.14)	0 (0.00)	5 (4.42)
Enterobacter spp.	1 (4.55)	0 (0.00)	1 (3.33)	0 (0.00)	1 (7.14)	0 (0.00)	3 (2.65)
Proteus spp.	1 (4.55)	0 (0.00)	0 (0.00)	1 (6.25)	0 (0.00)	0 (0.00)	2 (1.77)
Citrobacter spp.	0 (0.00)	1 (5.26)	1 (3.33)	2 (12.50)	0 (0.00)	0 (0.00)	4 (3.54)
Candida spp.	1 (4.55)	1 (5.26)	1 (3.33)	0 (0.00)	0 (0.00)	0 (0.00)	3 (2.65)
Total	**22**	**19**	**30**	**16**	**14**	**12**	**113**

In the present study a total of 17 antibiotics were used to workout the sensitivity/resistance pattern of various micro-organisms. Table 4 shows the antibiotic sensitivity/resistance pattern of *various microorganisms*.

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Antibiotic (Table 4)

Klebsiella spp.		*Pseudomonas*		*E.coli*		Micro organism
	Sensitivity		Resistance		Sensitivity	
Percentage	No.	Percentage	No.	Percentage	No.	
6.9	2	65.71	23	37.14	13	Gentamicin
3.45	1	77.14	27	22.86	8	Pipracillin-
34.48	10	88.57	31	2.86	1	Ampicillin
3.45	1	20	7	60	21	Trimethoprim-
27.59	8	62.86	22	25.71	9	Nitrofurantoin
79.31	23	22.86	8	54.29	19	Ciprofloxacin
13.79	4	54.29	19	20	7	Cefotaxime
20.69	6	14.29	5	48.57	17	Ceftazidime
65.52	19	25.71	9	62.86	22	Cefepime
72.41	21	8.57	3	82.86	29	Colistin
0	0	82.86	29	0	0	Amoxicillin
37.93	11	74.29	26	17.14	6	Levofloxacin
82.76	24	31.43	11	28.57	10	Amikacin
10.34	3	48.57	17	34.29	12	Imipenem
0	0	88.57	31	0	0	Piperacillin
0	0	40	14	17.14	6	Ceftriaxone
0	0	80	28	0	0	Vancomycin

E.coli				Micro organism
	Resistance		Sensitivity	
Percentage	No.	Percentage	No.	
26.32	5	68.42	13	Gentamicin
15.79	3	63.16	12	Pipracillin-
57.89	11	10.53	2	Ampicillin
52.63	10	47.37	9	Trimethoprim-
10.53	2	78.95	15	Nitrofurantoin
57.89	11	31.58	6	Ciprofloxacin
47.37	9	47.37	9	Cefotaxime
26.32	5	57.89	11	Ceftazidime
57.89	11	42.11	8	Cefepime
63.16	12	15.79	3	Colistin
47.37	9	0	0	Amoxicillin
68.42	13	10.53	2	Levofloxacin
10.53	2	78.95	15	Amikacin
5.26	1	84.21	16	Imipenem
73.68	14	21.05	4	Piperacillin
26.32	5	31.58	6	Ceftriaxone
78.95	15	5.26	1	Vancomycin

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Staphy aureus		*Enterococcus*				*Acinetobacter* spp.					
	Sensitivity		**Resistance**		**Sensitivity**		**Resistance**		**Sensitivity**		**Resistance**
Percentage	**No.**	**Percentage**	**No.**	**Percentage**	**No.**	**Percentage**	**No.**	**Percentage**	**No.**	**Percentage**	**No.**
75	٤	80	4	20	1	10	1	60	6	65.52	19
25	١	80	4	20	1	30	3	50	5	79.31	23
0	0	100	5	0	0	90	9	0	0	93.1	27
75	3	20	1	80	4	60	6	20	2	72.41	21
50	2	80	4	0	0	80	8	0	0	55.17	16
75	3	100	5	0	0	90	9	0	0	3.45	1
50	2	80	4	0	0	60	6	10	1	75.86	22
0	0	80	4	0	0	70	7	10	1	62.07	18
0	0	80	4	0	0	90	9	0	0	13.79	4
25	1	20	1	80	4	10	1	80	8	3.45	1
0	0	60	3	0	0	80	8	0	0	89.66	26
0	0	80	4	0	0	80	8	0	0	51.72	15
0	0	80	4	0	0	60	6	10	1	10.34	3
25	1	60	3	20	1	70	7	40	4	89.66	26
0	0	80	4	0	0	70	7	10	1	86.21	25
100	4	100	5	0	0	80	8	0	0	82.76	24
75	3	80	4	0	0	80	8	0	0	86.21	25

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Enterobacter spp.		*Enterobacter* spp.				*Citrobacter* spp.					
	Sensitivity		**Resistance**		**Sensitivity**		**Resistance**		**Sensitivity**		**Resistance**
%	**No.**	**%**	**No.**	**%**	**No.**	**Percentage**	**No.**	**Percentage**	**No.**	**Percentage**	**No.**
0	0	66.67	2	0	0	50	2	50	2	25	1
0	0	66.67	2	0	0	25	1	75	3	75	3
0	0	100	3	0	0	50	2	25	1	100	4
100	3	0	0	100	3	25	1	75	3	25	1
0	0	100	3	0	0	75	3	0	0	50	2
0	0	100	3	0	0	0	0	100	4	25	1
0	0	66.67	2	0	0	50	2	50	2	25	1
0	0	33.33	1	0	0	100	4	0	0	100	4
0	0	100	3	0	0	75	3	0	0	100	4
66.67	2	33.33	1	66.67	2	50	2	25	1	50	2
0	0	66.67	2	0	0	75	3	0	0	75	3
0	0	66.67	2	0	0	75	3	0	0	75	3
33.33	1	33.33	1	33.33	1	50	2	25	1	75	3
33.33	1	33.33	1	33.33	1	25	1	75	3	50	2
0	0	100	3	0	0	75	3	0	0	75	3
0	0	66.67	2	0	0	50	2	25	1	0	0
0	0	100	3	0	0	75	3	0	0	25	1

		Resistance																		
		No.	2	2	3	0	3	3	2	1	3	1	2	2	1	1	3	2	3	
		%	66.67	66.67	100	0	100	100	66.67	33.33	100	33.33	66.67	66.67	33.33	33.33	100	66.67	100	
***Proteus* spp.**	**Sensitivity**	**No.**	0	0	0	1	0	0	0	0	0	2	0	0	1	1	0	0	0	
		%	0	0	0	50	0	0	0	0	0	100	0	0	50	50	0	0	0	
	Resistance	**No.**	2	2	1	1	1	2	2	1	1	0	2	2	1	1	1	2	2	
		%	100	100	50	50	50	100	100	50	50	0	100	100	50	50	50	100	100	
***Candida* spp.**	**Sensitivity**	**No.**	1	1	0	1	0	0	0	1	0	2	0	0	0	1	0	0	0	
		%	33.33	33.33	0	33.33	0	0	0	33.33	0	66.67	0	0	0	33.33	0	0	0	
	Resistance	**No.**	2	2	3	1	2	3	3	1	2	1	3	2	2	1	2	3	2	
		%	66.67	66.67	100	33.33	66.67	100	100	33.33	66.67	33.33	100	66.67	66.67	33.33	66.67	100	66.67	

Table 5: Shows the duration of hospital stay of patients included in the present study.

Variables	Hospital stay (days) Mean ± SD
Direct	7.10 ± 1.36
Transferred	24.33 ± 3.96
Mean stay ± SD	13.5 ± 8.90

Discussion

Nosocomial infections or healthcare-associated infections encompass all clinically evident infections that do not originate from patient's original admitting diagnosis.[4] The incidence of nosocomial infections is about 5-10% in most developed nations while in India, one in four patients admitted into hospital acquire nosocomial infection.[5]

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In the present study a total of 92 samples were recovered from 40 patients over a period of 1 year out of which 53 (57.61 %) showed growth of micro-organisms. Among these 53 samples the highest frequency was noticed for Swab (87.50 %) which was followed by Pus (76.00%) and urine (71.43%), while lowest percentage was noticed in blood samples (27.78%). The results of the present study are in agreement with the earlier reports of Saghati *et al*.[6] In another study by Aggarwal *et al.* the major source of infection were from sputum and tracheostomy specimen (28.57%), followed by pus (24.13%), urine (19.04%), Cerebrospinal fluid and other sterile body fluids (15.38%) and blood (7.14%).[7]

In the current study 10 types of micro-organisms were isolated viz., *E. coli*, *Pseudomonas* spp., *Klebsiella* spp., *Acinetobacter* spp., *Staphy aureus*, *Enterococcus*, *Enterobacter* spp., *Proteus* spp., *Citrobacter* spp. and *Candida* spp. among which the highest percentage (30.97%) was recorded for *Pseudomonas* spp. which was followed by *Klebsiella* spp. (25.66%) and *E.coli* (16.81%), while the lowest percentage was recorded for *Proteus* spp. (1.77%). This is in agreement with previous studies from Pakistan and other countries. These findings are similar to those reported from India and Turkey. [8,9,10,11] In the study carried out in India, among the 60 patients, 35 (58.3 %) had microbiological confirmation and the organisms isolated were *Klebsiella pneumoniae, Pseudomonas aeruginosa, Stenotrophomonas maltophilia and Citrobacter freundii*.[12] In another study carried out over a period of twelve months in a tertiary-care teaching hospital located in the south-eastern part of Turkey the percentages of most frequently isolated microorganisms in ICU were *Pseudomonas aeruginosa* 20.3 %, *Candida* species 15 %, *Staphyloccus aureus* 12.9 %, *Acinetobacter baumannii* 9.6 %, and coagulase-negative staphylococci 8.9 %.[13] In an ICU of Fatmawati Hospital, Indonesia during January 2009 to March 2010, the most predominant isolates were *Pseudomonas aeruginosa* followed by *Klebsiella pneumoniae* and *Staphylococcus epidermidis* which supports the present findings.[14]

The study also revealed that among 10 micro-organisms isolated, *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pneumoniae* and *Acinetobacter* were found in all types of samples and were most frequent. These findings are in close agreement with the earlier reports of Jones *et al.* [15] In another prospective, observational and multicenter study in 27 intensive care units in nine European countries to compare risk factors, pathogens and outcomes between bacteremic nosocomial pneumonia, the most prevalent pathogen was *Acinetobacter baumannii* followed by MRSA.[16]

A total of 17 antibiotics were used to workout the sensitivity/ resistance pattern of various micro-organisms in the present study. Among the various antibiotics used, *E.coli* showed low to moderate resistance to imipenem, amikacin, nitrofurantoin, gentamicin, pipracillin-tazobactam and ceftazidime which is in contrast with the earlier reports of Yismaw who reported high level of resistance of *E. coli* to these antibiotics.[17] According to Namboodiri *et al*, these antibiotics have been subjected to widespread abuse resulting in the high rates of resistance.[18] Antibiotic resistance develops when microorganisms are exposed to effective doses of an antibiotic within a shorter period or when the microorganisms are exposed to smaller concentrations or residues of the antibiotic over a longer period of time .[19]

Most of the *P. aeruginosa* isolates obtained in the study were resistant to ampicillin. This result is similar to a study conducted by Strateva *et al* in Europe where more than 90% of *P. aeruginosa* isolates were resistant to ampicillin.[20] Resistance to ampicillin is largely due to the production of extended spectrum β-lactamase (ESBL) enzymes by the bacteria. All the strains of *P. aeruginosa* showed high resistance to piperacillin. Shenoy *et al* also reported that all strains of *P. aeruginosa* in their study were resistance to piperacillin.[21]

Present study revealed that *Klebsiella* spp. showed highest sensitivity to amikacin, ciprofloxacin and colistin and *Acinetobacter* spp. showed high sensitivity to colistin. Similar results were also observed by Radji *et al*.[22]

All *Acinetobacter* spp. isolates in our study were highly resistant to majority of antimicrobial agents tested, a finding that concur with previous study of Mshana *et al*.[23] *Acinetobacter* spp. showed low resistance to Gentamicin and Colistin. These findings are in close agreement with the earlier reports of Blomberg *et al*.[24]

In the present investigation *S. aureus* isolates were highly resistant to ampicillin, Ceftazidime and Cefepime. These findings concur with previous studies done in Tanzania which also reported high resistance rates of *S. aureus* to these antibiotics.[25] These findings may be as result of injudicious use of these drugs in the study population leading to high selection pressure of resistant bacteria.

The study revealed that *Enterococcus, Enterobacter* spp., *Proteus* spp., *Citrobacter* spp. and *Candida* spp. were highly resistant to gentamicin, ampicillin, ciprofloxacin, cefotaxime, ceftriaxone and amoxicillin, while they were highly sensitive to trimethoprim- sulfamethoxazole, colistin and imipenem. These results are in conformity with the earlier reports of several workers.[26] This may be due to the antibiotics having been in use for much longer time and their oral route of administration that affects their rate of absorption into blood stream.

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Summary and Conclusion

Forty patients showing different types of infections were included in this study. Majority of the patients were found in age group of 51-60 years with mean age of 51.43 ± 12.87 years. 92 samples were collected which included 39.13, 27.17, 8.70, 7.61, 10.87 and 6.52 per cent blood, urine, swab, sputum, pus and ETT samples, respectively. From these samples 27.78, 76.0, 87.5, 71.43, 80.0 and 33.33 per cent samples of blood, urine, swab, sputum, pus and ETT, respectively were found positive i.e. showed the growth of micro-organisms. A total of 10 types of micro-organisms were isolated (*E.coli*, *Pseudomonas* spp., *Klebsiella* spp., *Acinetobacter* spp., *Staphy aureus*, *Enterococcus*, *Enterobacter* spp., *Proteus* spp., *Citrobacter* spp. and *Candida* spp.) from six types of samples among which maximum number of micro-organisms were isolated from swab which was followed by blood and urine, while minimum number of micro-organisms were isolated from ETT. Further, among ten micro-organisms isolated, the highest percentage was recorded for *Pseudomonas* spp. which was followed by *Klebsiella* spp. and *E.coli*, while the lowest percentage was recorded for *Proteus* spp. In the present study a total of 17 antibiotics were used to workout the sensitivity/resistance pattern of various micro-organisms. Among the various antibiotics used, imipenem, amikacin, nitrofurantoin, gentamicin, pipracillin-tazobactam and ceftazidime were found highly sensitive to most of the micro-organisms isolated. Similarly, with regard to the resistant reaction, most of the micro-organisms showed highly resistant reaction with amoxicillin, ciprofloxacin, levofloxacin, ceftriaxone, piperacillin and vancomycin. The mean duration of hospital stay of patients which were directly admitted to ICU was 7.10 days, while patients which were transferred from in-patient department to ICU was 24.33 days.

Conclusion

We found most of the Gram negative isolates were multiply resistant to commonly prescribed antimicrobial agents. The high rate of antibiotic resistance in the present study shows that imipenem, amikacin, nitrofurantoin, gentamicin, pipracillin-tazobactam and ceftazidime are the only reliable agents for the empirical treatment of ICU infections. However, the current scenario appears to be the result of ineffective infection control measures and antibiotic policies. Hence, for proper management of critically ill patients in ICUs, hospital antibiotic policies need frequent revisions.

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