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Studying the Prevalence of Predominant Bacterial Micro-Organisms in MICU Along-with their Drug Sensitivity and Antimicrobial Resistance Pattern

[1]Prasad S. Korulkar and [2]Shailaja V. Rao

[1]Department of Medicine, Dr Vaishampayan Memorial Government Medical College, Opp. to District Court, Solapur 413003, India

[2]Department of Geriatric Medicine, Government Medical College, Panchakki Road, Aurangabad, India

ABSTRACT

Incidence of different organisms in infections acquired in community as well as healthcare set ups vary across different countries and even in different studies. Emergence of new pathogenic strains as well as MDR strains has brought into focus the importance of bacterial surveillance. Further microbial flora and their susceptibility pattern to antibiotics tend to change over time in particular set up. Hence, it is necessary to have knowledge regarding spectrum of microbes and their sensitivity pattern at individual healthcare set up. The above study was conducted at the Medical intensive care unit of a tertiary care hospital from January 2012 to December 2013. Samples of the 883 patients admitted in the MICU were included in this study. All isolates were obtained from a wide range of clinical samples (e.g., urine, pus, blood, sputum, tracheal secretions). Samples were processed for culture and sensitivity testing at department of microbiology. These isolates were studied on the basis of site of infection, characteristics of patients, clinical signs and symptoms, antimicrobial resistance pattern, thus identified as true pathogens. Proportion of gram negative organisms was greater than gram positive organisms. Respiratory isolates were least resistant to Carbapenems, Piperacillin-Tazobactum. Urinary isolates were found least resistant to amikacin and meropenem. For *Klebsiella pneumoniae* resistance to meropenem increased from 27.30-50.80%. Resistance to amikacin decreased from 67.60-50%. Prevalence of bacteria differs in different health set ups. Antibiotic resistance profile for any bacterial isolate need not be similar in any two health set ups. For rational use of antibiotics, profile of prevalent organisms and their resistance/sensitivity pattern should be known.

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Key Words
Bacterial, micro-organisms, MICU, drug, resistance

Corresponding Author
Prasad S. Korulkar,
Department of Medicine, Dr Vaishampayan Memorial Government Medical College, Opp. to District Court, Solapur 413003, India

Author Designation
[1]Assistant Professor
[2]Associate Professor and Head

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INTRODUCTION

The fight between man and microbes has been ongoing ever since antibiotics were introduced in 20th century. Despite initial success of antibiotics in combating infections, microbes have definitely won the war. Emergence of new pathogenic strains as well as MDR strains has brought into focus the importance of bacterial surveillance. Role of this data cannot be overemphasized while choosing empirical antibiotic in patients with critical illness. Several studies have shown that outcome of patients improves with proper selection of empiric antibiotic. Incidence of different organisms in infections acquired in community as well as healthcare set ups vary across different countries and even in different studies. Further microbial flora and their susceptibility pattern to antibiotics tend to change over time in particular set up. Hence ideally it is necessary to have knowledge regarding spectrum of microbes and their sensitivity pattern in individual healthcare set up like medical intensive care unit[1].

Therefore, the above study was conducted to find out the organisms causing infection in patients admitted in MICUs and to know the resistance pattern of isolates. Knowledge of the antibiotic susceptibility of the organisms isolated in the MICU can help to formulate an antibiotic policy for the MICU.

MATERIALS AND METHODS

Study place: The above study was conducted the above study was conducted at the medical intensive care unit of a tertiary care hospital from January 2012 to December 2013.

Study design: Observational study.

Inclusion criteria: Patients showing clinical signs of infection such as fever >38°C, Leukocytosis >10000 mm^{-3}, infiltrates on chest x-ray, persistent tracheal aspirates/secretions, turbid urine and those who were ready to give written consent for participation were included.

Exclusion criteria: Patients having no clinical signs of infection and unwilling to give consent for participation were excluded.

Sample size: 883.

Data analysis: Data was collected in pre-defined case report format.

Ethical considerations: All the necessary permissions were taken from the institutional ethics committee before beginning the study.

All isolates were obtained from a wide range of clinical samples (e.g., urine, pus, blood, sputum, tracheal secretions) from MICU patients. Samples were processed for culture and sensitivity testing at department of microbiology. These isolates were studied on the basis of site of infection, characteristics of patients, clinical signs and symptoms, antimicrobial resistance pattern, thus identified as true pathogens.

RESULTS

Overall in the study period, Gram negative bacilli (GNB) were most prevalent. In GNB, prevalence of *Klebsiella pneumoniae* (112/342) (33%) was highest followed by *Pseudomonas* spp. (57/342) (17%). In Gram positive organisms *Staphylococcus aureus* was predominant (66/342) (19%). Prevalence of Kleibsiella pneumoniae was decreased from 42% in 2012 to 29% in 2013. Prevalence of *Pseudomonas* spp. increased from 14% in 2012 to 18% in 2013. Prevalence of *Staphylococcus aureus* was increased from 14% in 2012 to 22% in 2013 (Table 1 and 2).

Cefamycins. 66.70% resistance reported to Amikacin. Resistance to Ceftazidime/Clavulanic acid, Piperacillin, Meropenem and Piperacillin/Tazobactum was 71, 50, 32.40 and 31.20%, respectively (Table 3).

57.10% of respiratory isolates were sensitive to Piperacillin-Tazobactum. 54.10% sensitivity reported to Amikacin. 40.80% were sensitive to Meropenem while Fluoroquinolones were sensitive to 35.40% of respiratory isolates tested. None to 31.70% sensitivity was reported for various Cephalosporins tested (Table 4).

During the study year from 2012-2013 all urinary isolates tested for Amikacin and Meropenem were sensitive. Samples tested for Quinolones and Cephalosporins were 100% resistant. In 2013, isolates tested for Cefamycins, Cephalosporins, Quinolones were resistant. All isolates tested for Meropenem were sensitive. Sixty percent sensitivity was reported for Amikacin in 2013 as compared to 100% in 2012 (Table 5 and 6).

Table 1: Total number of isolates

Organism	No. of isolates
Klebsiella pneumoniae	112
Pseudomonas spp.	57
Staph aureus	66
Escherichia coli	33
Citrobacter	20
Acinetobacter	14
Others	40
Total	342

Table 2: Numbers of isolates and organisms obtained in 2012 and 2013

Organism	No. of Isolates in 2012	No. of Isolates in 2013
Klebsiella pneumoniae	43	69
Pseudomonas spp.	15	42
Staph aureus	14	52
Escherichia coli	9	24
Acinetobacter	7	16
Citrobacter	4	7
Others	13	27
Total	105	237

Table 3: Antibiotic sensitivity pattern of respiratory isolates observed in 2012

Antibiotic name	Antibiotic class	Antibiotic subclass	Code	No.	R (%)	I (%)	S (%)	R 95% C.I. (%)
Amikacin	Aminoglycosides		AMK	72	66.7	6.9	26.4	54.5-77.1
Cefoxitin	Cephems	Cephamycins	FOX	10	90	10	0	54.1-99.5
Ceftazidime/clavulanic acid	Beta-lactam+Inhibitor		CCV	31	71	3.2	25.8	51.8-85.1
Imipenem	Penems	Carbapenems	IPM	12	0	41.7	58.3	0.0-30.1
Meropenem	Penems	Carbapenems	MEM	37	32.4	27	40.5	18.5-49.9
Piperacillin	Penicillins	Ureidopenicillins	PIP	8	50	0	50	17.4-82.6
Piperacillin/tazobactam	Beta-lactam+Inhibitor		TZP	16	31.2	25	43.8	12.1-58.5
Trimethoprim/sulfamethoxazole	Folate pathway inhibitors		SXT	7	100	0	0	56.1-100
Cefoperazone	Cephems	Cephalosporin II	CFP	6	100	0	0	51.7-100

Table 4: Antibiotic sensitivity pattern of respiratory isolates observed in 2013

Antibiotic name	Antibiotic class	Antibiotic subclass	Code	No.	R (%)	I (%)	S (%)	R 95% C.I. (%)
Amikacin	Aminoglycosides		AMK	133	36.8	9	54.1	28.7-45.6
Amoxicillin/clavulanic acid	Beta-lactam+Inhibitor		AMC	28	100	0	0	85.0-100
Ampicillin	Penicillins	Aminopenicillins	AMP	30	100	0	0	85.9-100
Cefepime	Cephems	Cephalosporin IV	FEP	32	75	3.1	21.9	56.2-87.9
Cefotaxime	Cephems	Cephalosporin III	CTX	50	70	14	16	55.2-81.7
Cefoxitin	Cephems	Cephamycins	FOX	111	84.7	3.6	11.7	76.3-90.6
Ceftazidime	Cephems	Cephalosporin III	CAZ	63	52.4	15.9	31.7	39.5-65.0
Ceftazidime/clavulanic acid	Beta-lactam+Inhibitor		CCV	71	56.3	14.1	29.6	44.0-67.9
Ceftriaxone	Cephems	Cephalosporin III	CRO	1	100	0	0	5.5-100
Ciprofloxacin	Quinolones	Fluoroquinolones	CIP	82	57.3	7.3	35.4	45.9-68.0
Clindamycin	Lincosamides		CLI	15	100	0	0	74.7-100
Colistin	Lipopeptides		COL	6	50	0	50	13.9-86.1
Erythromycin	Macrolides		ERY	31	96.8	3.2	0	81.5-99.8
Gentamicin	Aminoglycosides		GEN	23	73.9	8.7	17.4	51.3-88.9
Imipenem	Penems	Carbapenems	IPM	1	100	0	0	5.5-100
Linezolid	Oxazolidinones		LNZ	2	100	0	0	19.8-100
Meropenem	Penems	Carbapenems	MEM	142	43.7	15.5	40.8	35.5-52.3
Piperacillin/tazobactam	Beta-lactam+Inhibitor		TZP	35	28.6	14.3	57.1	15.3-46.6
Tetracycline	Tetracyclines		TCY	31	71	9.7	19.4	51.8-85.1
Trimethoprim/sulfamethoxazole	Folate pathway inhibitors		SXT	57	82.5	3.5	14	69.7-90.9
Cefoperazone	Cephems	Cephalosporin II	CFP	97	77.3	8.2	14.4	67.5-84.9
ESBL			ESBL	7	100		0	

Table 5: Antibiotic sensitivity pattern of urinary isolates observed

Antibiotic name	Antibiotic class	Antibiotic subclass	Code	No.	R (%)	I (%)	S (%)	R 95% C.I. (%)
Amikacin	Aminoglycosides		AMK	2	0	0	100	0.0-80.2
Meropenem	Penems	Carbapenems	MEM	1	0	0	100	0.0-94.5
Nalidixic acid	Quinolones	Quinolones	NAL	2	100	0	0	19.8-100
Norfloxacin	Quinolones	Fluoroquinolones	NOR	1	0	100	0	0.0-94.5
Cefoperazone	Cephems	Cephalosporin II	CFP	1	100	0	0	5.5-100

Table 6: Antibiotic sensitivity pattern of urinary isolates in 2012

Antibiotic name	Antibiotic class	Antibiotic subclass	No.	R (%)	I (%)	S (%)	R 95% C.I. (%)
Amikacin	Aminoglycosides		5	40	0	60	7.3-83.0
Cefotaxime	Cephems	Cephalosporin III	2	100	0	0	19.8-100
Cefoxitin	Cephems	Cephamycins	1	100	0	0	5.5-100
Ceftazidime	Cephems	Cephalosporin III	1	100	0	0	5.5-100
Ceftriaxone	Cephems	Cephalosporin III	1	100	0	0	5.5-100
Ciprofloxacin	Quinolones	Fluoroquinolones	2	100	0	0	19.8-100
Gentamicin	Aminoglycosides		1	100	0	0	5.5-100
Meropenem	Penems	Carbapenems	1	0	0	100	0.0-94.5
Nalidixic acid	Quinolones	Quinolones	1	100	0	0	5.5-100
Nitrofurantoin	Nitrofurans		2	50	50	0	2.7-97.3
Norfloxacin	Quinolones	Fluoroquinolones	3	100	0	0	31.0-100
Trimethoprim/sulfamethoxazole	Folate pathway inhibitors		4	100	0	0	39.6-100
Cefoperazone	Cephems	Cephalosporin II	2	50	0	50	2.7-97.3
Trimethoprim/sulfamethoxazole	Folate pathway inhibitors		1	100	0	0	5.5-100

Table 7: Antibiotic sensitivity pattern of blood cultures in 2012

Antibiotic name	Antibiotic class	Antibiotic subclass	No.	R (%)	I (%)	S (%)	R 95% C.I (%)
Cefoxitin	Cephems	Cephamycins	2	0	0	100	0.0-80.2
Trimethoprim/sulfamethoxazole	Folate pathway inhibitors		2	0	0	100	0.0-80.2

All blood isolates were sensitive to Cephamycins and Trimethoprim/ Sulfamethoxazole in 2012 as well as in 2013. Additional 100% sensitivity was observed in 2013 to Aminopenicillins, Lincosamides and Macrolides. 66.70% sensitivity was reported to Meropenem and Piperacillin/Tazobactam. 50% resistance noted to Amikacin and Cefoperazone each. 33.33% resistance noted to Meropenem and Ceftazidime/Clavulanic acid (Table 7 and 8).

Amikacin, Piperacillin-Tazobactam and Meropenem were the most effective antibiotics against *Klebsiella pneumoniae* during study period. In 2012, 67.60% isolates of *Klebsiella pneumoniae* were resistant to Amikacin. Resistance decreased to 50% in 2013. Resistance to Meropenem increased from 27.30% in 2012 to 50.80% in 2013. Number of isolates resistant to Piperacillin-Tazobactam remained same throughout study period (50%). Resistance to

Table 8: Antibiotic sensitivity pattern of blood cultures in 2013

Antibiotic name	Antibiotic class	Antibiotic subclass	No.	R (%)	I (%)	S (%)	R 95% C.I. (%)
Amikacin	Aminoglycosides		2	50	0	50	2.7-97.3
Amoxicillin/clavulanic acid	Beta-lactam+Inhibitor		1	0	0	100	0.0-94.5
Ampicillin	Penicillins	Aminopenicillins	1	0	0	100	0.0-94.5
Cefoxitin	Cephems	Cephamycins	3	0	0	100	0.0-69.0
Ceftazidime/clavulanic acid	Beta-lactam+Inhibitor		3	33.3	33.3	33.3	1.8-87.5
Clindamycin	Lincosamides		1	0	0	100	0.0-94.5
Meropenem	Penems	Carbapenems	3	33.3	0	66.7	1.8-87.5
Piperacillin/tazobactam	Beta-lactam+Inhibitor		3	0	33.3	66.7	0.0-69.0
Tetracycline	Tetracyclines		1	0	0	100	0.0-94.5
Cefoperazone	Cephems	Cephalosporin II	2	50	50	0	2.7-97.3

Table 9: Trend in antibiotic resistance for *Klebsiella pneumoniae*

Klebsiella pneumoniae	AMK	FEP	CTX	FOX	CAZ	CCV	CIP	GEN	MEM	TZP	CFP	ESBL
2012	67.60	25.00	16.66	16.66		80.00			27.30	50	100	
2013	50.00	82.40	91.30	59.10	60.70	78.80	42.30		50.80	50.00	95.70	100

Table 10: Trend in antibiotic resistance for *Pseudomonas aeruginosa* observed

Pseudomonas aeruginosa	AMK	FEP	CTX	FOX	CAZ	CCV	CIP	COL	MEM	TZP	CFP	ESBL
2012	60.00	11.11	44.44	33.33		57.10			71.40	12.50	100	
2013	13.90	28.60	40.00	92.90	17.60	22.20	23.10	50	25.00	6.20	35.00	100

Table 11: Antibiotic resistance for *Staphylococcus aureus*

Staph aureus	AMC	AMP	FOX	CIP	CLI	ERY	GEN	LNZ	TCY	SXT
2012			90.00							100
2013	100	100	87.20	100	100	100	69.20	100	81.00	83.70

cephalosporins increased overall during study period except for Cefoperazone (100% in 2012 and 95.70% in 2013). Resistance to Ceftriaxone and Cefoxitin increased from 16.66% in 2012 to 91.30 and 59.10% respectively. Resistance to Cefepime also increased from 25-82.40% during study period (Table 9).

Amikacin, Cefepime, Ceftriaxone, Ceftazidime, Ceftazidime/Clavulanic acid, Cefoperazone, Piperacillin-Tazobactam and Meropenem were effective antibiotics against *Pseudomonas aeruginosa* during study period. In 2012, 60% isolates of *Pseudomonas aeruginosa* were resistant to Amikacin. Resistance decreased to 13.90% in 2013. Resistance to cephalosporins was variable during study period. Resistance to Cefepime and Cefoxitin increased from 11.11% and 33.33% in 2012 to 28.60% and 92.90% in 2013 respectively. Resistance to Ceftriaxone and Ceftazidime/Clavulanic acid decreased from 44.44% and 57.10% in 2012 to 40% and 22.20% in 2013, respectively. Resistance to Ceftazidime and Ciprofloxacin was 17.60 and 23.10% in 2013. Resistance to Meropenem decreased from 71.40 to 25% during study period. Piperacillin-Tazobactam was consistently active against *Pseudomonas aeruginosa* during study period with resistance of 12.50% in 2012 and 6.20% in 2013 (Table 10).

Staphylococcus aureus isolates were totally resistant to Cefoxitin and Trimethoprim/ Sulfamethoxazole in 2012. In 2013, 100% resistance was noted to Amoxicillin/Clavulanic acid, Aminopenicillins, Ciprofloxacin, Clindamycin and Linezolid. 87.20% resistance was noted to Cefoxitin. Gentamicin and Tetracycline resistance was reported to 69.20 and 81% *Staphylococcus aureus* isolates respectively (Table 11).

DISCUSSIONS

In present study bacterial isolation rate was 41.70%. In the similar study done by Radji *et al*.[4] isolation rate was 64.68% whereas Bhaumik *et al.*[2] from B.J. Medical College, Ahmedabad reported 39.10% isolation rate. Zaveri *et al*.[3] from College of Medical Sciences, Amargadh, Bhavnagar reported isolation rate of 42.66%. Most common organism isolated during study period was *Klebsiella pneumoniae* (33%) followed by *Pseudomonas* spp. and *Staphylococcus aureus* (17 and 19%). Jain and Khety[5] reported similar observation in their study conducted at Saifee Hospital, Mumbai. Bhaumik *et al*.[2] from B.J. Medical College, Ahmedabad reported *Pseudomonas* spp. (29.12%) as most common organism isolated followed by *Klebsiella* spp. (28.08%). Zaveri *et al*.[3] from College of Medical Sciences, Amargadh, Bhavnagar reported *E. coli*, *Acinetobacter* spp. and *Pseudomonas* spp. (21.28%). In present study, prevalence of Klebsiella pneumoniae decreased from 35% in 2012 to 24% in 2013. Jain and Khety[5] reported increase in prevalence of Klebsiella pneumoniae in their study. Prevalence of *Pseudomonas* spp. increased from 12% in 2012 to 15% in 2013. Prevalence of *Staphylococcus aureus* increased from 14% in 2012 to 18% in 2013. Jain and Khety[5] reported decrease in prevalence of *Staphylococcus aureus* from 25-12%. For *Pseudomonas* spp. sensitivity for Meropenem and Piperacillin-Tazobactum raised from 28.60-66.70% and from 75-93.80%, respectively, in present study. Jain and Khety[5] noted that the sensitivity of *Pseudomonas aeruginosa* to Meropenem has decreased from 90-60%. The antibiotic that remained most active against all gram negative organisms for 2 years was Imepenem, Piperacillin-tazobactam and Amikacin.

Zaveri *et al*.[3] also reported Piperacillin-Tazobactum being sensitive against *Pseudomonas* spp. (65%) followed by Cefoperazone-Sulbactum (55%). In present study, Amoxicillin-Clavulinic Acid found consistently resistant against *Staphylococcus aureus* over study period. Fagade *et al*.[6] reported 42% sensitivity to Amoxicillin-Clavulinic Acid. Drug Cefoxitin and Gentamicin was found effective against *Staphylococcus aureus* (sensitivity 12.80-15.40%, respectively).

CONCLUSION

From the present study it appears that the prevalence of bacteria differs in different health set ups. Bacterial isolates seemingly prevalent in particular set up can be negligible in another setting. It is also apparent from the study that antibiotic resistance profile for any bacterial isolate need not be similar in any two health set ups. Therefore, antibiotic prescription pattern for some infection in some hospital/set up may not be applicable for another e.g., in present study sensitivity of *Pseudomonas* to Meropenem increased from 28.60-66.70% in contrast to other study which reported decrease in sensitivity from 90-60%. For rational use of antibiotics, profile of prevalent organisms and their resistance/sensitivity pattern should be known and prescription of antibiotics should be done based on local data.

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