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Original Article

Bacteriological Profile Andantibiogram of ICU Isolates in A Tertiary Care Institute in Manipur – A Six-Year Study

Preety Samom[1]; Gurumayum Preeti[2*]; Supriya Laifangbam[3]; Monika Nahakpam[1]

[1] Post-graduate trainee, Department of Microbiology, Jawaharlal Nehru Institute of Medical Sciences, Imphal
[2] Assistant Professor, Department of Microbiology, Jawaharlal Nehru Institute of Medical Sciences, Imphal
[3] Professor, Department of Microbiology, Jawaharlal Nehru Institute of Medical Sciences, Imphal.

ABSTRACT

Introduction: Patients hospitalized in the intensive care units (ICUs) are 5 to 10 times more likely to acquire nosocomial infections than other patients admitted in the hospital. The frequency of infections at different anatomic sites and the risk of infection vary by the type of ICU, and the frequency of specific pathogens varies by infection site. Contributing to the seriousness of nosocomial infections, especially in ICUs, is the increasing incidence of infections caused by antibiotic-resistant pathogens.

Aims and objectives: To evaluate the bacteriological profile and their antibiotic sensitivity pattern in intensive care unit (ICU) settings of a tertiary care institute.

Material and methods: It is a6-yearretrospective study conducted in the Department of Microbiology, Jawaharlal Nehru Institute of Medical Sciences from 2017 January to 2023 January. The bacterial isolates from the clinical samples were identified and antibiotic susceptibility testing were done by Kirby Bauer disc diffusion method and VITEK 2 automated system. Data were recorded as numbers and proportions.

Result: Of the total 1547 samples received in 6 years, 508 were bacterial culture positive. Majority of the bacterial isolates were from urine followed by blood, sputum, surgical wounds, stool, CSF, etc. In our study, most of the bacterial isolates were found to be Gram-negative bacilli while the remaining were Gram-positive cocci. Out of the 508 bacterial isolates, the highest culture positivity was from Surgery ICU. The most frequently identified isolates were Escherichia coli, Staphylococcus aureus, Klebsiella pneumoniae, Pseudomonas aeruginosa, Acinetobacter baumanii, CoNS, Enterococcus faecalis, Proteus mirabilis, Salmonella typhi, etc.

Conclusion: Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, Proteus mirabilis, Pseudomonas aeruginosa, etc were thecommon isolates from our study. The study alsoshows that the susceptibility of the first line drugs and second line drugs are low. Nosocomial infections, especially those caused by antibiotic-resistant pathogens, represent an important source of morbidity and mortality for the patients hospitalized in an ICU setting.

Key Words: *ICU, Antibiotic susceptibility, Bacteriological profile.*

***Corresponding Author**
Gurumayum Preeti
Assistant Professor, Department of Microbiology, Jawaharlal Nehru Institute of Medical Sciences, Imphal

INTRODUCTION

Antibiotics are the cornerstone of therapy for infected critically ill patients[1]. With the high rate of hospital-acquired infection (HAI) in India in recent years, antibiotic therapy has become a mandatory part of most patients admitted in the ICUs. ICU is one of the most potential sources of nosocomial infections. Patients hospitalized in ICUs are 5% to 30% more likely to acquire nosocomial infections than other hospital patients since these patients are likely to require invasive medical devices during the hospital stay[2]. Medical devices are responsible for a large portion of nosocomial infections, mainly in critically ill patients[3].The frequency of infections at various anatomic sites and the risk of infection differ by the type of ICU, and the rate of infection by specific pathogens varies by infection site[4]. Mortality and morbidity of infected patients were twice that of non-infected patients in the ICU[5].Contributing to the seriousness of nosocomial infections, particularly in ICUs, is the ever-increasing incidence of infections caused by antibiotic-resistant pathogens[6].Moreover, nosocomial infections lead to longer hospital stays, higher costs and mortality. The study aims to help in finding the most effective treatment for bacterial infections in ICU patients.

Aims and objectives

The aim of our study is to evaluate the bacteriological profile and their antibiotic sensitivity pattern in intensive care unit (ICU) settings of a tertiary care institute.

Materials and methods

A retrospective study was conducted for a period of 6 years from January 2017 to January 2023in the Department of Microbiology, Jawaharlal Nehru Institute of Medical Sciences, Imphal, Manipur. Theclinical isolates from blood, urine, sputum, surgical wound swabs, stool, cerebrospinal fluid (CSF),aspirates, pus, central lines, catheterised sites, other wound swabswere identified by conventional methods andVITEK 2 automated system[7]. Positive cultures were isolated and antibiotic susceptibility testing were performed using Kirby Bauer disc diffusion method[8].For antibiotics like vancomycin, in case of *Staphylococcus aureus* and colistin for the Gram-negative bacteria,Minimum Inhibitory Concentration (MIC) was performed by VITEK 2 automated system as per Clinical Laboratory Standard Institute (CLSI) guidelines[9].Antibiotics namely amikacin, ciprofloxacin, co-trimoxazole, imipenem, meropenem, nitrofurantoin, piperacillin-tazobactam, ceftazidime, levofloxacin, colistin were used Gram-negative bacteria and co-trimoxazole, erythromycin, amoxicillin-clavulanic acid, vancomycin, linezolid, ciprofloxacin, high level gentamicin, gentamicin, tetracycline teicoplanin were used for Gram-positive bacteria.For routine Quality Control of antibiotic susceptibility test, S. aureus ATCC 25923, E. coli ATCC 25922, and Pseudomonas aeruginosa ATCC 27853 were used. Data were collected from the registry of the bacteriology section of the Department of Microbiology,JNIMS.

Inclusion criteria:

- All samples sent to the bacteriology laboratory of Department of Microbiology from all the ICUs of the institute.

Exclusion criteria:

- Samples that have been contaminated.

Statistical analysis: It was done using Microsoft Excel Sheet. Data were reported in numbers and portions.

Fig 1: Gender wise distribution of sample from various ICUs

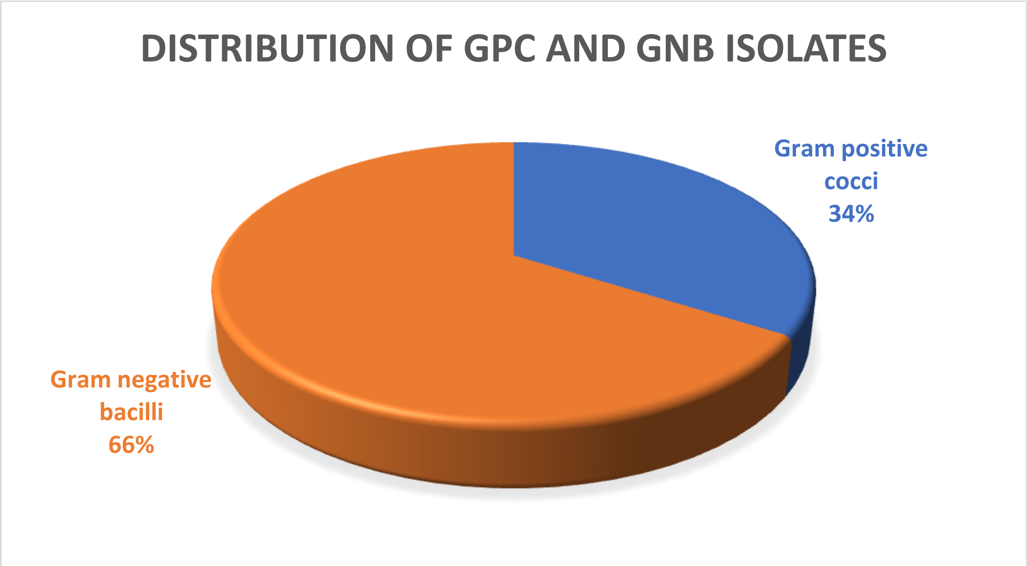

Fig 2: Distribution of the bacterial isolates into Gram-positive cocci and Gram-negative bacilli

Results

Table 1: Year-wise distribution of number of samples collected and number of cultures isolated.			
YEAR	TOTAL NO. OF SAMPLE RECEIVED	NO. OF CULTURE ISOLATED	CULTURE POSITIVITY (%)
2017-18	234	59	25.2%
2018-19	285	85	29.8%
2019-20	121	23	19%
2020-21	194	46	23.7%
2021-22	397	174	43.8%
2022-23	316	121	38.2%
TOTAL	1547	508	32.83%

Table 2: Specimen-wise distribution of samples collected and culture positivity.		
DATA COLLECTED (SPECIMEN-WISE)		
SPECIMEN	NO. OF SPECIMENS RECEIVED FOR CULTURE	CULTURE POSITIVITY (%)
URINE	590	284 (55.9%)
BLOOD	554	104 (20.47%)
ASPIRATES	127	40 (7.87%)
SPUTUM	120	26 (5.11%)
WOUND AND PUS	49	23 (4.52%)
SURGICAL WOUND SWAB	45	20 (3.93%)
STOOL	33	5 (0.98%)
OTHER	19	5 (0.98%)
CSF	10	1 (0.19%)
TOTAL	1547	508

CSF – cerebrospinal fluid; Others: ascitic fluid, bone marrow aspiration fluid, Ryle's tube tip, etc

Table 3: Distribution of clinical isolates into various groups

	Urine (%)	Blood (%)	Aspirates (%)	Sputum (%)	Wound And Pus(%)	Surgical wounds(%)	Stool (%)	Others (%)	CSF (%)	Total (%)
Enterobacteriaceae	174 (61.26)	14 (13.46)	26 (65)	11 (42.3)	13 (56.52)	7 (35)	-	5 (100)	0	250 (49.21)
NFGNB	29 (10.21)	23 (22.11)	8 (20)	6 (23.07)	3 (13.04)	11 (55)	4 (80)	0	1 (100)	85 (16.73)
Staphylococci	48 (16.9)	61 (58.65)	5 (12.5)	9 (34.61)	7 (30.43)	2 (10)	1 (20)	0	0	133 (26.18)
Enterococci	36 (12.67)	6 (5.76)	1 (2.5)	-	0	0	0	0	0	43 (7.87)

CSF – cerebrospinal fluid; NFGNB: non-fermenting gram-negative bacilli

Table 4: Distribution of the bacterial isolates into different ICUs

Organism	SICU (%)	MICU (%)	GICU (%)	RICU (%)	ICCU (%)	ATC ICU (%)	COVID ICU (%)	NICU (%)	PICU (%)	NSICU (%)	Total
E.coli	25 (23.58%)	30 (28.30%)	9 (8.4%)	5 (4.71%)	6 (5.66%)	10 (9.43%)	8 (7.54%)	3 (2.83%)	8 (7.54%)	2 (1.88%)	106 (20.86%)
K. pneumoniae	24 (32.87%)	18 (24.65%)	5 (6.84%)	7 (9.58%)	2 (2.73%)	4 (5.47%)	5 (6.84%)	2 (2.73%)	4 (5.47%)	2 (2.73%)	73 (14.37%)
K.oxytoca	2 (7.69%)	5 (19.23%)	4 (15.38%)	5 (19.23%)	2 (7.69%)	3 (11.53%)	2 (7.69%)	3 (11.53%)	0	0	26 (5.11%)
P.mirabilis	2 (9.09%)	4 (18.18%)	3 (13.63%)	4 (18.18%)	1 (4.54%)	1 (4.54%)	2 (9.09%)	1 (4.54%)	0	4 (18.18%)	22 (4.33%)
P.vulgaris	2 (14.28%)	3 (21.42%)	1 (7.14%)	0	3 (21.42%)	2 (14.28%)	1 (7.14%)	1 (7.14%)	1 (7.14%)	0	14 (2.75%)
P.aeruginosa	18% (37.5%)	9 (18.75%)	3 (6.25%)	6 (12.5%)	2 (4.16%)	0	2 (4.16%)	4 (8.33%)	0	4 (8.33%)	48 (9.44%)
A.baumanii	16 (43.24%)	3 (8.10%)	6 (16.21%)	2 (5.4%)	2 (4.16%)	0	0	7 (18.91%)	2 (5.4%)	0	37 (7.28%)
S.typhi	0	3 (33.33%)	0	0	0	0	0	2 (22.22%)	4 (44.44%)	0	9 (1.77%)
E.faecalis	3 (11.53%)	5 (19.23%)	3 (11.5%)	0	3 (11.53%)	3 (11.53%)	5 (19.2%)	1 (3.84%)	1 (3.84%)	2 (7.69%)	26 (5.11%)
E.faecium	2 (13.33%)	2 (13.33%)	3 (20%)	0	3 (11.53%)	2 (13.33%)	1 (6.66%)	0	1 (6.66%)	2 (13.33%)	15 (2.95%)
S.aureus	19 (18.81%)	24 (23.7%)	6 (5.94%)	8 (7.92%)	10 (9.9%)	8 (7.92%)	7 (6.93%)	6 (5.94%)	5 (4.95%)	8 (7.92%)	101 (19.88%)
CoNS	5 (15.62%)	5 (15.62%)	4 (12.5%)	3 (9.37%)	4 (12.5%)	2 (6.25%)	2 (6.25%)	0	6 (18.75%)	1 (3.12%)	32 (6.29)
Total	114 (22.44%)	108 (21.25%)	47 (9.2%)	39 (7.67%)	36 (7.08%)	36 (7.08%)	32 (6.29%)	31 (6.10%)	30 (5.9%)	25 (4.9%)	_

SICU- surgical intensive care unit; MICU- medicine intensive care unit;GICU- gynaecology intensive care unit;RICU- respiratory intensive care unit;ICCU- intensive coronary care unit; ATC ICU- accident and trauma care intensive care unit; PICU- paediatric intensive care unit; NICU- neonatal intensive care unit;NSICU- neurosurgery intensive care unit.

Table 5: Susceptibility of Gram-negative bacilli to various antibiotics

	AMK (%)	CIP (%)	COT (%)	IMP (%)	MRP (%)	NIT (%)	PIT (%)	CTZ (%)	LE	COL
E.coli	79	51	39	97	95	81	44	54	26	100

K.pneumoniae	64	43	36	99	97	68	69	49	32	100
K.oxytoca	67	41	39	98	95	69	63	51	34	100
P.mirabilis	84	61	-	99	96	-	96	98	47	-
P.vulgari	81	74	-	98	91	-	89	94	49	-
P.aeruginosa	53	47	-	83	84	-	68	34	61	98
A.baumanii	25	-	-	78	71	-	39	49	14	99
S.typhi	19	21	37	69	71	-	42	39	-	100

AMK- amikacin; CIP- ciprofloxacin; COT- Co-trimoxazole; IMP- imipenem; MRP- meropenem; NIT- nitrofurantoin; PIT- piperacillin-tazobactam; CTZ- ceftazidime; LE- levofloxacin; COL- colistin;

Table 6: Susceptibility of Gram-positive cocci to various antibiotics

	COT (%)	E (%)	AMC (%)	VA (%)	LZ (%)	CIP (%)	HLG (%)	GEN (%)	TE	TEI
MRSA	33	36	59	96	92	15	-	-	78	69
MSSA	84	53	90	100	97	31	-	-	82	77
CoNS	52	27	-	-	92	49	-	-	90	-
E.faecalis	-	39	19	97	94	45	97	48	-	92
E.faecium	-	41	-	99	93	42	95	54	-	90

MRSA- methicillin resistant *Staphylococcus aureus;* MSSA- methicillin sensitive *Staphylococcus aureus;* CoNS- coagulase negative Staphylococcus; COT- co-trimoxazole; E- erythromycin; AMC- amoxicillin and clavulanic acid; VA – vancomycin; LZ – linezolid; CX- cefoxitin; HLG – high level gentamicin; GEN – gentamicin; TE- tetracycline; TEI- teicoplanin

Of the total 1547 samples received in 6 years, 508 (32.83%) were bacterial culture positive as summarized in **Table 1**. Female patients constituted 836(54.04%) while male patients constituted for 711 (45.95%) shown in **Fig 1.**Majority of the bacterial isolates were from urine culture with 284 (55.9%) followed by blood culture 104 (20.47%), aspirates 40 (7.87%), sputum 26 (5.11%), wound and pus 23 (4.52%), surgical wounds 20 (3.93%), stool and other samples such as ascitic fluid, bone marrow aspiration, Ryle's tube tip with 5 (0.98%) and CSF 1 (0.19%) as summarized in **Table 2.**In our study, most of the bacterial isolates were found to be Gram-negative bacilli at 335 (66%) while the remaining were Gram-positive cocci at 173 (34%) as shown in **Fig 2.**The overall distribution of the bacterial isolates from each kind of clinical sample has been summarized in **Table 3.**Out of the 508 bacterial isolates, the highest culture positivity was from Surgery ICU(22.44%) followed by Medicine ICU (21.25%), Gynaecology ICU (9.2%), Respiratory ICU (7.67%), Intensive coronary care unit(7.08%),Accident and trauma care ICU (7.08%), COVID ICU (6.29%), Neonatal ICU (6.10%), Paediatric ICU (5.9%) and Neurosurgery ICU (4.9%) shown in **Table 4**.The most frequently identified isolates were *Escherichia coli*106 (20.86%), followed by *Staphylococcus aureus*101 (19.88%), *Klebsiella pneumoniae*73(14.37%),*Pseudomonas aeruginosa*48(9.44%), *Acinetobacter baumanii*37 (7.28%), CoNS 32 (6.29%), *Klebsiella oxytoca* and *Enterococcus faecalis* at 26 (5.11%), *Proteus mirabilis* 22 (4.33%), *Enterococcus faecium* 15 (2.95%), *Proteus vulgaris* 14 (2.75%) and *Salmonella typhi* 9 (1.77%).The overall distribution of each of the bacterial isolates from various ICUs of the hospital has been summarized in **Table 4**.**Table 5** shows the antimicrobial susceptibility rates of the Gram-negative bacilli to various antibiotics such as amikacin, ciprofloxacin, cotrimoxazole, imipenem, meropenem, nitrofurantoin, piperacillin-tazobactam, ceftazidime, levofloxacin and colistin. Antimicrobial susceptibility rates of the Gram-positive cocci to various antibiotics namely cotrimoxazole, erythromycin, amoxicillin, vancomycin, linezolid, ciprofloxacin, high level gentamicin, gentamicin, tetracycline and teicoplanin as shown in **Table-6.**

DISCUSSION

Infection is a common incidence in the ICU patientsand a prerequisite to development of sepsis[10]. Antibiotics play a vital role in the prevention and control of these life-threatening infections[11].

In our study, there is a slight female preponderance.Majority of the samples were urine samples. Females are more prone to Urinary tract infections (UTI) as females have shorter urethra than males.We can correlatethese findings with similar findings obtained by Abebe *et al*[12] and Chakrapani *et al*[13]. In our study, among 508bacterial strains, the most commonly isolated was *Escherichia coli*(20.86%) followed by Staphylococcus aureus (19.88%). These findings are in tandem with the studies conducted by Aly M, *et al*[14]andden Heijer CD[15] respectively.

Among the ICUs, it was found that SICU has maximum bacterial isolates which is in tandem with a study by Basak*et al*[16], Roy A*et al*[17]. This may be due to breach in the skin or operative wound or due to presence of pre-operative indwelling urinary catheter which has been kept for longer days leading to Catheter Associated Urinary Tract Infection (CAUTI). Similar findings of CAUTI has been seen in study done by Tedja*et al*[18]. Hence, aseptic techniques during surgical procedure, regular dressing, early removal of catheter, encouraging fluid intake, using condom catheter and avoiding irrigation of the bladder can prevent such infections.

Analysis of the antibiogram of the bacterial isolates from various ICUs of the institute shows that the susceptibility to first-line and second-line antibiotics have greatly reducedover the years as compared to study conducted in the same institute by Chongtham U, *et al*[19] in the past years. With the decreased effectivenessof the first line as well as second line drugs, we have no means but to resort to thereserved and restricted drugs.

Severe or life-threatening infections are common among the intensive care unitpatients. Most infections in the ICU are bacterial or fungal in origin and require antimicrobial therapy for clinical resolution[20]. Empirical therapy with broad spectrum antibioticshas always been a mainstay of the treatment guidelines of patients in the ICUs since collection of microbiological evidence for infection is typically slow, and previous antibiotic exposure may render results unreliable[21]. Implementing AMSP (antimicrobial stewardship programme) in the ICU will improveantimicrobial utilization and reduces broad-spectrum antimicrobial use, incidence of infections andcolonization with MDRB (multi-drug resistant bacteria), antimicrobial-related adverse events, and healthcare-associated costs, all without an increase in mortality and morbidity[22].However, there is room for policy-practice gap perhaps due to knowledge, attitude, practices orbehaviourof the policy makers and healthcare providers owing to unpredictable infection dynamics.Here arises the need for the health care providers to work together to combat the silent tsunami of antimicrobial resistance facing modern medicine.

CONCLUSION

Nosocomial infections, especially those caused by antibiotic-resistant pathogens, represent an important source of morbidity and mortality for the patienthospitalized in an ICU. *Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, Proteus, Pseudomonas aeruginosa,* etc were the common isolates from our study. Our study shows the susceptibility of the first line drugs and second line drugs are low and the restricted drugs such as meropenem are the only remaining antibiotics available for treatment. The key to control of antibiotic-resistant pathogensin the ICU is rigorous adherence to infectioncontrol guidelines and prevention of antibiotic misuse.Antibiotic restriction policies clearly result inreduced drug costs.

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