IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Trends In Antibiotic Prescription And Bacterial Sensitivity In Critical And Surgical Care Units

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ABSTRACT

Background: Antimicrobial resistance (AMR) presents a significant global health challenge, contributing to over five million deaths annually worldwide. This study aimed to evaluate antibiotic prescribing patterns and analyze the antimicrobial sensitivity profiles of isolated organisms.

Methods: A Prospective observational study was conducted over a six-month period in the Intensive Care Unit (ICU) and surgical departments. A total of 102 patients were included in the study, based on the inclusion and exclusion criteria. Daily clinical evaluations were performed to monitor patient prognosis, and antibiotic-prescribed cases were systematically analyzed during ward rounds to identify trends in prescribing patterns. In addition, microbiological data, such as culture reports and antibiotic sensitivity patterns, were collected and analyzed to determine the effectiveness of various antibiotics against different pathogens.

Results: Analysis of antibiotic prescribing patterns revealed that cephalosporins were the most frequently prescribed class (31.6%), followed by carbapenems (18.7%) and penicillin (15.5%). Among the patient samples, 43 cultures exhibited positive microbial growth and were subjected to antibiotic sensitivity testing. *Escherichia coli* was the predominant isolate, accounting for 48.8% of the total. Sensitivity testing showed that *Pseudomonas aeruginosa* exhibited the highest sensitivity to netilmicin (67%). *E. coli* isolates were most sensitive to nitrofurantoin (100%), followed by imipenem (95%) and meropenem (95%). *Klebsiella pneumoniae* showed 100% sensitivity to cefoperazone/sulbactam, cefepime, imipenem, norfloxacin, and ciprofloxacin. Overall, netilmicin (90%) demonstrated the highest sensitivity across all isolates, followed by cefoperazone/sulbactam (87%) and piperacillin/tazobactam (85%).

Conclusion: These findings highlight the critical need for ongoing surveillance and the implementation of antimicrobial stewardship programs to promote the rational use of antibiotics and improve clinical outcomes in critical care and surgical settings.

Keywords: Antimicrobial resistance, Prescribing patterns, Rational drug use, Drug utilization, Sensitivity pattern.

I. Introduction

Infectious diseases exhibit a higher prevalence in developing countries, underscoring the essential role of antimicrobial agents in therapeutic interventions and public health strategies. However, the irrational and widespread misuse of antimicrobial agents in these settings has driven the emergence of antimicrobial resistance, resulting in therapeutic failure and adverse clinical outcomes.[1] This underscores the urgent need for preventive strategies within healthcare settings, particularly in intensive care units (ICUs) and surgical departments, such as strict hygiene protocols, antiseptic-based skin decolonization, and routine screening for multidrug-resistant organisms. To improve the effectiveness of antibiotic therapy, empirical treatments should align with the pharmacokinetic and pharmacodynamic (PK-PD) characteristics of the chosen drugs. Furthermore, strategies like shortening the duration of therapy and adjusting treatment based on culture findings can enhance antibiotic stewardship in ICUs and surgical wards. [2]

The decision to initiate antibiotic therapy is a critical consideration in the Intensive Care Unit (ICU). Due to the high index of suspicion for invasive infections in critically ill patients, compounded by the inherent challenges of diagnostic accuracy and the delayed results of laboratory tests, timely identification and management of infections remains complex. As anticipated, the frequency of antibiotic prescriptions in the Intensive Care Init (ICU) is nearly 10 times higher compared to general wards. The importance of initiating early empiric antibiotic therapy has been highlighted in numerous studies and is supported by clinical guidelines. [3]

Although there have been major improvements in surgical techniques and widespread antibiotic use, surgical site infections (SSIs) continue to be a leading cause of illness, death, and increased healthcare costs worldwide. SSIs are the most frequent healthcare-associated infections, typically arising from contaminated surgical tools or environments. To reduce the risk and impact of surgical site infections (SSIs), one widely recommended approach is the use of systemic antibiotics either before or during surgery—referred to as perioperative antibiotic prophylaxis (PAP). Research suggests that 30–50% of all antibiotics used in hospitals are for PAP, with up to 60% of surgical patients receiving postoperative antibiotics during their hospital stay, and as many as 50% being discharged with them. However, a large share of antibiotic use in surgical settings is deemed inappropriate, which significantly contributes to the growing problem of antimicrobial resistance (AMR). Antimicrobial resistance poses a significant global health threat, playing a role in over five million deaths annually across the world. Inappropriate use often stems from issues like incorrect dosing, timing, or duration of treatment, and the unnecessary use of broad-spectrum antibiotics when a narrow-spectrum option would be sufficient. Factors contributing to these prescribing errors include diagnostic uncertainty, complex patient conditions, limited prescriber experience, unfamiliarity with local resistance trends, inadequate lab resources, and misinterpretation of microbiological test results. Antibiotics are often prescribed empirically without specific justification. The World Health Organization (WHO) highlights the critical role of long-term surveillance in generating reliable data to guide the development and implementation of antibiotic prescribing policies and stewardship programs. [4]

Despite this, there has been a lack of research focused on long-term antibiotic use trends in ICU and surgical departments of private hospitals in India. To address this gap, the current study seeks to examine and report on antibiotic prescribing practices, trends, antimicrobial sensitivity profiles of commonly encountered pathogens and their appropriateness at the group level within ICU and surgical departments of the private hospital.

II. Research Methodology

This prospective observational study was conducted over a six-month period at a 1000-bed tertiary care hospital in Coimbatore. The study received ethical approval from the hospital's ethics committee and dean (Approval No. EC/2024/1602/CR-36), with support from both senior and junior physicians. The study focused on patients admitted to the Surgery and Intensive Care Unit (ICU) departments, both of which are known for their high frequency of antibiotic usage. A total of 102 patient samples were included based on the inclusion criteria: adults aged 18 and above who had received antibiotic therapy. Patients who declined participation, had incomplete medical records, or were pregnant or breastfeeding were excluded. Data collection involved regular ward visits and review of medication charts to record patient demographics (age, sex, weight), medical history, allergy status, admission reasons, length of stay, and details of antibiotic prescriptions, including drug type, dosage, and route of administration (oral or intravenous). Daily clinical evaluations were performed to monitor patient prognosis, and antibiotic-prescribed cases were systematically analyzed during ward rounds to identify trends in prescribing patterns. In addition, microbiological data, such as culture reports and antibiotic sensitivity patterns, were collected and analyzed to determine the effectiveness of various antibiotics against different pathogens.

III. RESULTS

TABLE NO: 1 GENDER DISTRIBUTION (n=102)

S. NO	GENDER	NO. OF PATIENTS	PERCENTAGE (%)
1.	Male	70	68.6%
2.	Female	32	31.4%

Gender distribution analysis showed that males comprised the majority of the study population, accounting for 68.6% of the total sample.

TABLE NO: 2 AGE WISE DISTRIBUTION (n=102)

S. NO	AGE CATEGORY (Years)	NO. OF PATIENTS	PERCENTAGE (%)
1.	20-29	10	9.8 %
2.	30-39	4	4 %
3.	40-49	11	10.8 %
4.	50-59	24	23.5 %
5.	60-69	18	17.6 %
6.	70-79	28	27.4 %
7.	80-89	7	6.9 %

From the study data, maximum number of patients 28 (27.45%) were between the age group of 70-79 years.

TABLE NO: 3 REASONS FOR ADMISSION (n=102)

S.NO	CATEGORIES OF ILNESS	NO. OF PATIENTS	PERCENTAGE (%)
1.	Infection	25	24.5%
2.	Renal compliance	16	15.7 %
3.	Respiratory illness	9	9%
4.	Orthopedics	7	6.8 %
5.	Hepatic illness	7	6.8 %
6.	CNS	6	5.8%
7.	Carcinoma	5	5 %
8.	CVS	4	4%
9.	GI Illness	3	2.9 %
10.	Others	20	19.6 %

The most common reason for admission was infection, which accounted for 24.5% of patients, followed by renal complications (15.7%) and other conditions.

TABLE NO: 4 ANTIBIOTIC THERAPY DISTRIBUTION AMONG PATIENTS (n=127)

S.NO	THERAPY	NO. OF CASES	PERCENTAGE (%)
1	Monotherapy	105	86.7 %
2	Fixed dose combinations	22	17.32%

The results indicate that 86.7% of patients received monotherapy, which is a significantly higher proportion compared to those who were administered fixed-dose combinations (17.32%).

TABLE NO: 5 NUMBER OF ANTIBIOTICS PRESCRIBED PER PRESCRIPTION (n=102)

S. NO	NO. OF ANTIBIOTICS	NO. OF CASES	PERCENTAGE (%)
1.	1	38	37.25 %
2.	2	30	29.41 %
3.	3	20	19.6 %
4.	4	9	8.82 %
5.	6	3	2.94 %
6.	5	2	1.96 %

The data show that the majority of patients (37.25%) were prescribed a single antibiotic, indicating a preference for monotherapy in clinical practice.

TABLE NO: 6 PRESCRIBING PATTERN OF ANTIBIOTICS (n=193)

S.NO	CLASS OF ANTIBIOTICS	NO. OF CASES	PERCENTAGE (%)
1.	Cephalosporins	61	31.6
2.	Carbapenem	36	18.7
3.	Penicillin	30	15.5
4.	Fluoroquinolones	12	6.2
5.	Tetracyclines	11	5.7
6.	Aminoglycosides	8	4.1
7.	Lincomycin	8	4.1
8.	Fluoroquinolones+ nitroimidazole	6	3.1
9.	Oxazolidinone	6	3.1
10.	Glycopeptide	6	3.1
11.	Anti – TB agents	3	1.6
12.	Macrolides	2	1
13.	Non- systemic	2	1

14.	Nitroimidazole	1	0.5
15.	Polypeptide	1	0.5

Analysis of antibiotic prescribing patterns revealed that Cephalosporins were the most frequently prescribed class (31.6%), followed by Carbapenems (18.7%) and Penicillin (15.5%).

TABLE NO: 7 SENSITIVITY PATTERN OF ANTIBIOTICS (n=102)

S.NO	CATEGORIES	NO. OF CASES	PRECENTAGE (%)
1.	Culture-positive cases	43	42.15%
2.	Culture not indicated	59	57.84%

Out of the 102 study participants, 42.15% samples showed positive bacterial growth based on microbiological data.

TABLE NO: 8 ANALYSES OF SESITIVITY PATTERN IN VARIOUS DEPARTMENTS (n=43)

DIVISIONS	FREQUENCY	PERCENTAGE (%)
Nephrology	10	23.2%
General medicine	6	14%
Pulmonology	6	14%
Neurology	5	11.6%
Urology	4	9.3%
Endocrinology	4	9.3%
Hepatology	3	7%
Cardiology	3	7%
Orthopedics	2	4.6%

Among the 43 cases with bacterial isolates for which sensitivity patterns were reported, the highest proportion, 23.2% was observed in Nephrology department.

TABLE NO: 9 FREQUENCIES OF BACTERIAL PATHOGENS ISOLATED (n=43)

ORGANISM ISOLATED	NO. OF PATIENTS	PERCENTAGE (%)
E. coli	21	48.8%
Klebsiella pneumoniae	6	14%
Pseudomonas aeruginosa	6	13.9%
Enterococcus faecium	4	19.3%
Enterococcus faecalis	2	4.7%
Staphylococcus aureus	2	4.7%
Proteus mirabilis	1	2.3%
Stenotrophomonas maltophilia	1	2.3%

In our study, *Escherichia coli* was the most frequently isolated organism, accounting for 48.8% of the culture-positive cases, followed by *Klebsiella pneumoniae* (14%) and *Pseudomonas aeruginosa* (13.9%).

TABLE NO: 10 DISTRIBUTIONS OF BACTERIAL ISOLATES FROM VARIOUS CLINICAL SPECIMENS (n=43)

ORGANISM	TRACHEAL	PUS	SPUTUM	BLOOD	MID URINE	CATHETERURINE	TOTAL (%)
Pseudomonas aeruginosa	1	4	-	-	2	2	10
E. coli	-	1	-	5	11	5	25
Enterococcus faecalis	-	-	-	-	2	-	2
Enterococcus faecium	-	-	-	1	2	1	4
Klebsiella pneumonia	1	-	2	-	5	-	9
Proteus mirabilis	-	-	-	1	-	-	1
Stenotrophomonas maltophillia	-	-	-	1	-	-	1
Staphylococcus aureus	-	-	1	1	1	1	1
Total Isolates	2 (3.5%)	5 (8.8%)	3 (5.3%)	9 (15.8%)	23 (40.4%)	9 (15.8%)	57 (100%)

Various clinical specimens were collected for culture sensitivity testing, with the highest proportion of isolates (40.4%) obtained from midstream urine samples, followed by catheter urine 9 (15.8%) and blood (15.8%).

TABLE NO: 11 ANTIMICROBIAL SENSITIVITY PATTERN OF ISOLATED ORGANISMS (n=43)

Organism	*P.aeruginosa*		*E.coli*		*E.faecalis*		*E.faecium*		*K.pneumoniae*		*S.aureus*		*P.mirabilis*	
Antibiotics	R	S	R	S	R	S	R	S	R	S	R	S	R	S
Ceftriaxone	100 %	-	91%	-	-	-	-	-	40%	60%	-	-	-	-
Cefotaxime	100 %	-	89%	11%	-	-	-	-	40%	60%	-	-	-	-
Ceftazidime	67%	33 %	89%	11%	-	-	-	-	57%	43%	-	-	-	-
Cefoperazone/ Sulbactam	50%	50 %	10%	90%	-	-	-	-	-	100%	-	-	-	-
Cefipime	50%	50 %	62%	38%	-	-	-	-	-	100%	-	-	100 %	-
Cefuroxime	-	-	91%	9%	-	-	-	-	83%	17%	-	-	-	-
Imipenem	80%	20 %	5%	95%	-	-	-	-	-	100%	-	-	-	-
Meropenem	66%	34 %	5%	95%	-	-	-	-	17%	83%	-	-	-	-
Ertapenem	100 %	-	7%	93%	-	-	-	-	25%	75%	-	-	-	-
Netilmicin	33%	67 %	7%	93%	-	-	-	-	-	100%	-	-	-	-
Tobramycin	50%	50 %	64%	36%	-	-	-	-	-	100%	-	-	-	-
Gentamicin	-	-	55%	45%	-	-	-	-	20%	80%	-	-	-	-

Amikacin	50%	50 %	40%	60%	-	-	-	-	17%	83%	-	-	-	-
Piperacillin/ Tazobactam	50%	50 %	9%	91%	-	100 %	-	-	17%	83%	-	-	-	100 %
Penicillin	100 %	-	-	-	-	-	-	-	-	-	100 %	-	-	-
Ampicillin	100 %	-	100 %	-	-	100 %	75%	25%	-	-	-	-	-	-
Linezolid	-	-	-	-	-	100 %	-	100 %	-	-	-	100 %	-	-
Doxycyclin e	-	-	38%	62%	-	-	-	-	50%	50%	-	100 %	-	-
Tetracycline	100 %	-	75%	25%	-	-	100 %	-	-	-	-	-	-	-
Norfloxacin	100 %	-	86%	14%	-	-	100 %	-	-	100%	-	-	-	-
Ciprofloxaci n	50%	50 %	100 %	-	-	100 %	100 %	-	-	100%	-	-	-	-
Nitrofuranto in	-	-	-	100 %	-	100 %	100 %	-	67%	33%	-	-	-	-

R – Resistant, S - Sensitive

Based on the data, Pseudomonas aeruginosa shows the highest sensitivity to Netilmicin (67%). E. coli demonstrates the greatest sensitivity to Nitrofurantoin (100%), followed by Imipenem and Meropenem (both 95%).

TABLE NO: 12 OVERALL ANTIBIOTIC SENSITIVITY PROFILE OF BACTERIAL ISOLATES (n=43)

S.NO	ANTIBIOTICS	RESISTANT	SENSITIVE
1.	Netilmicin	10%	90%
2.	Cefoperazone+ Sulbactam	13%	87%
3.	Piperacillin+ Tazobactam	15%	85%
4.	Imipenem	16%	84%
5.	Meropenem	18%	82%
6.	Ertapenem	19%	81%
7.	Nitrofurantoin	25%	75%
8.	Amikacin	35%	65%
9.	Doxycycline	37.5%	62.5%
10.	Gentamicin	44.4%	55.6%
11.	Tobramycin	47%	53%
12.	Cefepime	53%	47%
13.	Ciprofloxacin	71%	29%
14.	Penicillin	71.4%	28.6%
15.	Tetracycline	76%	24%
16.	Ofloxacin	77%	23%
17.	Ceftazidime	78%	22%
18.	Ceftriaxone	82%	18%
19.	Cefotaxime	82%	18%
20.	Norfloxacin	84%	16%
21.	Ampicillin	86.2%	13.8%
22.	Cefuroxime	89%	11%

The findings of the current study reveal that Netilmicin (90%) exhibited the highest sensitivity among all antibiotics tested, followed closely by Cefoperazone + Sulbactam (87%) and Piperacillin + Tazobactam

(85%). These were followed by the carbapenems — Imipenem (84%), Meropenem (82%), and Ertapenem (81%) — indicating strong efficacy of these antibiotics against the isolated organisms.

IV. DISCUSSION

This study presents findings on antibiotic resistance patterns observed in both ICU and surgical department at a tertiary care hospital in Coimbatore, India. It includes an analysis of various pathogens and corresponding antibiotic therapies, offering a detailed overview of resistance trends among the patients. The results of the gender categorization revealed that the study population was predominantly male, a finding that aligns with the study conducted by C.R. Jayanthi et al,[5] which also reported a higher number of male patients in their population. After analyzing the age distribution, our study found that antibiotics were most frequently prescribed to patients between the age group 70-79 years and 50-59 years. This is consistent with the findings of the study conducted by Nirmal Raj Marasine et al,[6] who reported a mean age of 50.60 (20.18) years, with the majority (51.0%) of patients being older than 50 years. Based on the reasons for admission, 10 categories of illnesses were identified, with the highest number of patients presenting with infections. This finding aligns with the study conducted by J. Goncalves Pereira et al,[7] who concluded that most patients were diagnosed with infections upon admission. The current study found that most patients were administered a single antibiotic, which is in line with the study conducted by Nikhilesh Anand et al,[8] who reported an average of 1.73 antibiotics per patient.

Among the 15 classes of antibiotics, the majority of patients were prescribed cephalosporins, which is consistent with the study conducted by Nikhilesh Anand et al,[8] who concluded that cephalosporins were the most commonly prescribed antibiotic. The analysis of isolated organisms from tested patients revealed that *E. coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Enterococcus faecium* were frequently identified. These findings align with the study conducted by Rama Biswas et al,[9] which also highlighted the prevalence of these pathogens in similar samples. Various samples were collected for culture sensitivity tests, with the highest number of organisms isolated from midstream urine. This finding is similar to the study conducted by Rama Biswas et al,[9] which concluded that the culture-positive rate for uropathogens was high. The antimicrobial potency and spectrum of various agents across different classes against the isolated organisms were summarized. *Pseudomonas aeruginosa* showed high sensitivity to Netilmicin, while *E. coli* was most sensitive to nitrofurantoin, imipenem, and meropenem. After analyzing the overall antimicrobial sensitivity pattern, Netilmicin demonstrated the highest sensitivity against the organisms.

V. CONCLUSION

The drug utilization and sensitivity pattern analysis in the ICU and surgery ward highlights several important findings. The high utilization rates of antibiotics prescribed at admission in these areas raise concerns and point to the need for improvement through the implementation of guidelines, surveillance, and antibiotic restriction policies in healthcare settings. The evaluation also reveals discrepancies in prescribing patterns, underscoring the need for ongoing education and monitoring to ensure optimal antibiotic selection, dosage, and duration. Moreover, timely de-escalation of broad-spectrum antibiotics is essential in reducing unnecessary exposure.

The study further emphasizes the importance of evidence-based prescribing practices, ensuring that antibiotics are selected according to local antimicrobial sensitivity patterns to improve treatment efficacy and minimize resistance development. It stresses the necessity for strict adherence to antibiotic guidelines to prevent misuse and overuse, both of which contribute significantly to antibiotic resistance.

These findings highlight the urgent need for standardized guidelines, protocols, educational interventions, surveillance, and antibiotic stewardship programs in these settings. Clinical pharmacists play a critical role in ensuring the rational use of antibiotics, reinforcing their importance in the healthcare system.

ACKNOWLEDGEMENT: We would like to express our gratitude to S.N.R. Sons Charitable Trust, Sri Ramakrishna Hospital, and Principal Dr.S.Sriram of College of Pharmacy, Sri Ramakrishna Institute of Paramedical Sciences, Coimbatore, for providing the necessary facilities to conduct this study.

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