Section: Miscellaneous

Original Research Article

A CROSS-SECTIONAL STUDY ON RESTRICTED ANTIBIOTICS IN A TERTIARY CARE CENTER

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Abstract

Background: Antibiotics are among the most frequently prescribed drugs in hospitals, particularly in Intensive Care Units (ICUs), where broad-spectrum antibiotics are often used empirically. The availability of effective antibiotics since the mid-20th century has saved millions of lives, but overuse has led to rising antibiotic resistance, a growing public health issue globally, with more severe implications in developing countries. In hospital misuses appropriate prescribing practices and widespread antibiotic misuse are common, contributing to increased healthcare costs, treatment failures, and adverse reactions. **Materials and Methods:** This cross-sectional, hospital-based study was conducted at Sri Lalithambigai medical college and hospital in Chennai. The study included ICU patients prescribed restricted antibiotics, such as Carbapenems (Imipenem, Meropenem), Glycopeptides (Vancomycin), and others. Data on demographics, antibiotic usage, dosage, and clinical outcomes were collected from patient charts. Descriptive statistics were used to summarize the data, and chi-square tests were conducted to examine associations between variables. Logistic regression models controlled for confounding factors such as age, sex, and ICU stay duration. **Result:** Out of 368 patients, 56% were male. The most frequently prescribed antibiotics were Imipinem (38%), Linezolid (21.7%), and Vancomycin (13.6%). Sepsis was the most common indication for antibiotic use (58.2%). Resistance was highest for Linezolid (29.2%), Vancomycin (25%), and Imipinem (20.8%). E. coli (30.8%) was the most common resistant pathogen. Recovery rates showed no significant difference between genders (p=0.712), though morbidity was slightly higher in males. **Conclusion:** The study found significant use of restricted antibiotics in ICU settings, with a high prevalence of resistance, particularly to Linezolid and Vancomycin. It highlights the need for stricter adherence to antibiotic guidelines, culture-based prescribing, and increased training for healthcare professionals to curb the growing threat of antibiotic resistance.

INTRODUCTION

Antibiotics are among the most frequently prescribed drugs in hospitals, often selected on an empirical basis, with broad-spectrum antibiotics being commonly used.[1] It is estimated that nearly one-third of all hospitalized patients receive at least one antibiotic during their stay. This usage is particularly prevalent in Intensive Care Units, where patients with severe conditions are more likely to receive antibiotics. The severity of a patient's illness and their varying resistance capabilities necessitate that clinicians prescribe antibiotics based on individual clinical patterns. Since the mid-20th century, the availability of effective, affordable antibiotics has been widespread, but the increasing resistance to these antibiotics has become a significant public health issue in the 21st century.[2] Antibiotic resistance, primarily driven by overuse, poses a substantial challenge worldwide, with a higher prevalence in developing countries compared to developed ones.[3]

While antibiotics have saved millions of lives, their effectiveness is threatened by bacteria evolving to become resistant. In both developed and developing nations, the rapid rise of resistant pathogens in hospitals often renders antibiotic treatments ineffective, resulting in longer hospital stays, increased side effects, irrational prescribing practices, and heightened treatment costs.[4,5] For instance, research has shown that more than 50% of medications globally are prescribed, dispensed, or sold inappropriately.[6,7]

Despite numerous studies on antibiotic use in developed nations, there is a lack of research focusing on developing countries like India.[8] It is reported

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that around 5% of hospitalized patients who take antibiotics experience adverse reactions, and 20% of patients require additional treatment due to these side effects.[9] In hospitals, 90% of antibiotics are prescribed based on clinical assessments, leading to potential misuse. Data from developing countries consistently point to inappropriate antibiotic use, though the evidence remains limited.[10,11] In India, approximately 50% of patients in tertiary care receive antibiotics without clear indications.[12] Therefore, understanding the patterns of antibiotic use in tertiary care centers and identifying patients' antibiotic resistance capacities is essential. The overuse of antibiotics also significantly increases healthcare costs. For instance, hospitals in India allocate about 50% of their drug budgets to antibiotics, far exceeding the proportion used by the general population accessing healthcare services. Overprescribing not only inflates costs but also increases the risk of infections from resistant bacteria and opportunistic fungi, leading to more frequent adverse drug reactions. Consequently, the indiscriminate and inappropriate prescribing of antibiotics presents a serious economic challenge for healthcare systems, especially in India. This calls for a more prudent and optimized use of antibiotics.[13]

Some hospitals have adopted the practice of prescribing restricted antibiotics to patients in tertiary care based on clinical need. These restricted antibiotics aim to combat multi-resistant organisms and are often reserved for severe infections caused by resistant pathogens. Restricting the use of certain antibiotics to specific patient groups and employing broad-spectrum antibiotics where appropriate can help slow the emergence of resistance and prolong the effectiveness of existing antibiotics.[14,15] Examples of these restricted antibiotics include Amikacin, Nalidixic acid, Cefuroxime, Amphotericin B, Ceftazidime, Linezolid, Ertapenem, Tobramycin, and Piperacillin-Tazobactam, among others.[15] However, a lack of sufficient knowledge among healthcare professionals about appropriate antibiotic selection for specific conditions continues to present a significant challenge in hospitals. Various studies have highlighted the inappropriate prescribing of antibiotics, leading to side effects and increasing healthcare costs.[4]

The inappropriate use of antibiotics, coupled with rising resistance, has severe consequences, including treatment failure and escalating healthcare expenses. Thus, this study aims to address these gaps by providing a detailed analysis of restricted antibiotic use in hospitals, particularly in intensive care settings. Additionally, it highlights the importance of controlling antibiotic consumption and optimizing usage to prevent resistance and reduce healthcare costs. Limited research exists on the types of antibiotics given to hospitalized patients, especially in developing countries like India, making it crucial to evaluate the safe, effective, and economically viable use of restricted antibiotics.[16] By filling this knowledge gap, this study supports future research efforts focused on understanding the overuse of antibiotics, regulatory factors, economic incentives, and the expectations of both patients and prescribers.

Aim

The study aimed to ascertain the antibiotic use pattern among the patients of ICU of tertiary care hospital in Chennai

Objectives:

- To describe the pattern of antibiotic use among the patients of ICU of tertiary care hospital in Chennai
- To assess the pattern of resistance of restricted antibiotics in terms of age, gender, specific issues with respect to restricted antibiotics, their dosage schedule, route of administration, related lab investigations and date of discontinuation.
- To study the various indications and usage of restricted antibiotics and the clinical recovery of patients in intensive care.

MATERIALS AND METHODS

Study Design: This research employed a cross-sectional, hospital-based study design. The study's design was chosen to assess antibiotic usage patterns in real-world hospital settings over a specific period.

Setting: The study was conducted at Sri Lalithambigai medical college and hospital, a prominent medical institution in Chennai, Tamil Nadu. The study spanned one year and included the recruitment of ICU patients, exposure to restricted antibiotics, patient follow-up, and data collection throughout this period.

Participants

Eligibility Criteria

The study included all ICU patients within the age group of XXX who were admitted to the tertiary care unit and received restricted antibiotics during their stay. These antibiotics included Carbapenems (Imipenem, Meropenem, Ertapenem, Doripenem), Glycopeptides (Teicoplanin, Vancomycin), Polymyxin B, Colistin, Tigecycline, and Linezolid.

Exclusion Criteria

Patients who fell outside the specified age group of XXX or those who did not receive restricted antibiotics were excluded from the study.

Selection Method: Patients were selected based on their prescription of restricted antibiotics, and the sample was drawn using a systematic sampling method after random selection of the initial patient card.

Variables: The primary outcome variables were the types of restricted antibiotics administered, dosage schedules, and routes of administration. Exposures included the duration of antibiotic treatment and the clinical condition of each patient. Potential confounders considered included patient demographics (age, gender), pre-existing conditions, and length of ICU stay. The study also examined the occurrence of adverse reactions to the antibiotics and any adjustments made to treatment plans. Additionally, lab investigation results and clinical

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patterns were reviewed to identify predictors of antibiotic resistance.

Data Sources and Measurement: Data were collected from patient treatment charts, which included detailed information on antibiotic prescriptions, demographic characteristics, laboratory investigations, and clinical outcomes. The primary data collection tool was a checklist, which was used to systematically gather patient information, including gender, age, route of administration, dosage, date of discontinuation, and adverse reactions. All patients receiving restricted antibiotics were followed up daily until discharge. For each variable of interest, data were recorded consistently across patients, ensuring comparability within the study sample.

Bias: To address potential sources of bias, systematic sampling was employed to avoid selection bias in patient inclusion. Furthermore, data collection was standardized using a checklist to minimize measurement bias. Any discrepancies in patient data were addressed immediately through verification with hospital records to reduce information bias.

Sample Size: The sample size of 368 was determined using the formula for single population proportion, aiming for a 95% confidence interval (CI) with a 5% margin of error. Based on an estimated 50% prevalence of restricted antibiotic use among ICU patients, the sample size calculation was done to ensure adequate statistical power.

$Ni = [(Z\ a/2)2p\ (1-p)]/d2$

Where,

$Z\alpha/2$ is probability coefficient for desired interval [CI = 95%],

ni = minimum sample size determined,

P = proportion of population possessing characteristics of interest /50% prevalence/,

d = margin of sampling error tolerated (5%),

1-p = proportion of population that do not possess the character of interest.

Statistical Methods

Descriptive statistics were used to summarize the data, including frequencies, percentages, and mean values. Chi-square tests were used to assess associations between categorical variables, such as antibiotic type and occurrence of adverse reactions. All the analyses were carried out using the SPSS 20.0 version.

RESULTS

The analysis of prescriptions shows that out of 368 patients, the majority were male (56%), followed by females (42.7%), with pediatric patients representing a small portion (1.4%). Recovery outcomes varied, with 36.2% achieving complete recovery, while 41.2% experienced morbidity, 12.8% mortality, and 12.3% had other outcomes. The most frequently prescribed antibiotic was Imipinem (38%), followed by Linezolid (21.7%) and Vancomycin (13.6%). Other antibiotics such as Meropenem (14.7%) and Polymyxin B (13%) were used moderately, while Doripinem was not prescribed at all. Tigecycline, Ertapenem, and Colistin were the least prescribed, representing less than 5% of cases.

Table 1: Baseline characteristics of the prescriptions analysed

Parameter	Frequency (n = 368)	Percent (%)
Gender		
Male	206	56.0
Female	157	42.7
Pediatric	5	1.4
Recovery Rate		
Complete Recovery	130	36.2
Morbidity	148	41.2
Mortality	46	12.8
Others	44	12.3
Antibiotics		
Imipinem	140	38
Meropenem	54	14.7
Doripinem	0	0
Ertapenem	2	0.5
Vancomycin	50	13.6
Teicoplanin	10	2.7
Linezolid	80	21.7
Polymyxin b	48	13
Colistin	6	1.6
Tigecycline	12	3.3

Table 2: Distribution of Culture Species, Indications for Antibiotic Use, and Resistance Patterns

Parameter	Frequency (n=221)	Percent (%)
Culture Species		
E coli	68	30.8
Staphylococcus	44	19.9
Klebsiella	40	18.1
Pseudomonas	38	17.2
Others	31	14

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Indication of Antibiotics		
Miscellaneous	67	18.2
Post op	82	22.3
Sepsis	214	58.2
Snake bite	23	6.2
Resistance Pattern		
Imipinem	5	20.8
Meropenem	3	12.5
Doripinem	0	0
Ertapenem	0	0
Vancomycin	6	25
Teicoplanin	2	8.3
Linezolid	7	29.2
Polymyxin b	3	12.5
Colistin	0	0
Tigecycline	6	25

Table 3: Distribution of Antibiotic Prescription Patterns by Gender

Drug	Association	Male n	Female n	Pediatric n	P-value
IMIPINEM	Absent	137	88	3	0.126
	Present	69	69	2	
MEROPENEM	Absent	172	137	5	0.390
	Present	34	20	0	
DORIPINEM	Absent	206	157	5	-
ERTAPENEM	Absent	205	156	5	0.968
	Present	1	1	0	
VANCOMYCIN	Absent	173	143	2	0.001
	Present	33	14	3	
TEICOPLANIN	Absent	203	150	5	0.204
	Present	3	7	0	
LINEZOLID	Absent	157	127	4	0.561
	Present	49	30	1	
POLYMYXIN B	Absent	179	136	5	0.682
	Present	27	21	0	
COLISTIN	Absent	201	156	5	0.394
	Present	5	1	0	
TIGECYCLINE	Absent	197	153	5	0.396
	Present	9	3	0	

Table 4: Distribution of Recovery and Morbidity by Gender

Parameter	Association	Male	Female	Pediatric	p-value
COMPLETE RECOVERY	Absent	131	103		0.712
	Present	75	54		
OTHERS	Absent	183	136	5	0.576
	Present	23	21	0	
MORBIDITY	Absent	124	95	1	0.188
	Present	82	62	4	
MORTALITY	Absent	179	138	5	0.668
	Present	27	19	0	

Table 5: Association Between Gender and Bacterial Infections

Gender	Association	Male	Female	Pediatric	p-value
E. COLI	Absent	87	65	1	0.154
	Present	37	28	3	
STAPHYLOCOCCUS	Absent	101	73	3	0.836
	Present	23	20	1	
KLEBSIELLA	Absent	101	76	4	0.637
	Present	23	17	0	
PSEUDOMONAS	Absent	103	76	4	0.633
	Present	21	17	0	
OTHERS	Absent	104	82	4	0.477
	Present	20	11	0	

Among the 221 patients who underwent culture testing, E. coli was the most frequently identified organism (30.8%), followed by Staphylococcus (19.9%), Klebsiella (18.1%), and Pseudomonas (17.2%). Antibiotics were most commonly indicated for sepsis (58.2%), with post-operative infections (22.3%) and miscellaneous conditions (18.2%) also being significant contributors. Snake bites accounted for 6.2% of the cases. Regarding antibiotic resistance, Linezolid showed the highest resistance pattern (29.2%), followed by Vancomycin (25%), Imipinem (20.8%), and Tigecycline (25%). No resistance was observed for Doripinem, Ertapenem, or Colistin.

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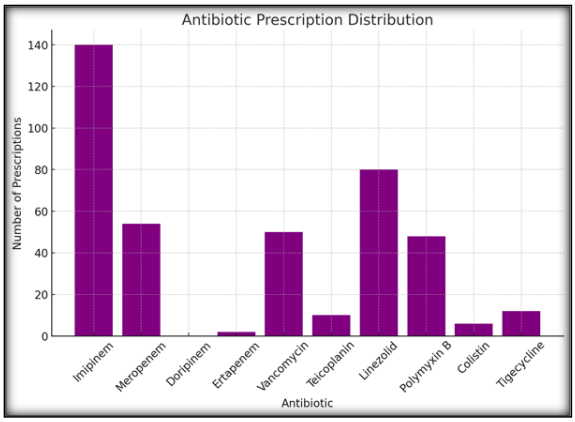

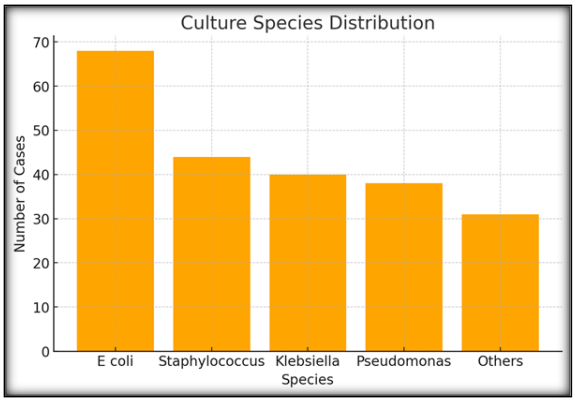

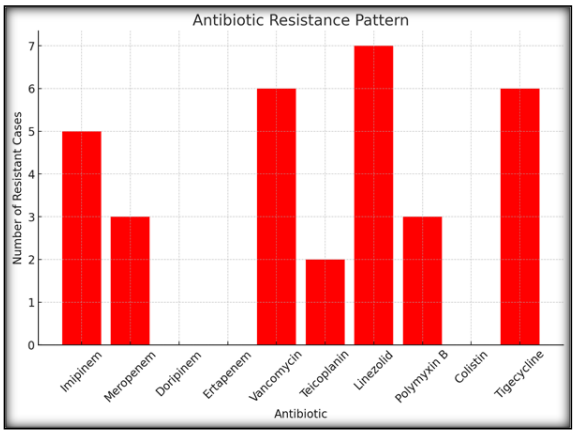

This table examines the association between gender and the prescription of various antibiotics. Imipinem was prescribed equally among males (49.3%) and females (49.3%), with a small percentage prescribed to pediatric patients. For Meropenem, males received more prescriptions (63%) than females (37%). Doripinem was not prescribed to any patient. Vancomycin showed a significant association, with males (66%) receiving more prescriptions compared to females (28%) and pediatric patients (6%) (p=0.001). The use of Teicoplanin, Linezolid, Polymyxin B, Colistin, and Tigecycline showed no statistically significant gender differences in prescription patterns.

Recovery rates did not show a significant difference between males (57.7%) and females (41.5%) for complete recovery (p=0.712). Morbidity was slightly higher in males (55.4%) compared to females (41.9%), but the difference was not statistically significant. Mortality rates were similar between genders, with males representing 58.7% and females 41.3%, and no significant difference was observed (p=0.668). The pediatric group had minimal representation across all categories.

This table explores the association between gender and different bacterial infections. For E. coli, males had a slightly higher rate of infection (54.4%) compared to females (41.2%), while pediatric patients had a notable presence (4.4%). Staphylococcus infections were equally distributed between males (52.3%) and females (45.5%), with a small percentage affecting pediatric patients (2.3%). Klebsiella and Pseudomonas infections were more common in males than females, with no significant infections observed in the pediatric group. Other bacterial infections were more prevalent in males (64.5%) compared to females (35.5%), though no significant statistical differences were found across all groups.

DISCUSSION

This study provides important insights into antibiotic use, bacterial infections, and clinical outcomes among ICU patients, and these findings align with other published research on the topic. The results highlight the critical need for targeted antibiotic use and enhanced antibiotic stewardship to combat growing antibiotic resistance, particularly in ICU settings where broad-spectrum antibiotics are frequently used.

The observed male predominance (56%) among ICU patients is consistent with other studies that report higher rates of ICU admission and sepsis among males. This gender difference may be linked to biological factors, such as the immunosuppressive effects of testosterone, which increases susceptibility to severe infections, while estrogen is believed to provide some protective effects against sepsis through anti-inflammatory mechanisms.[16,17]

However, despite these biological differences, the recovery and mortality rates between male and female patients in this study did not show significant differences. These findings contrast with a systematic review that suggested women may have a survival advantage in sepsis, although the underlying mechanisms remain unclear.

The frequent use of broad-spectrum antibiotics like Imipinem (38%) and Linezolid (21.7%) is typical of ICU practices, where empirical treatment is often necessary due to the severity of infections and the critical condition of patients. Similar studies have shown that broad-spectrum antibiotics are commonly used in ICUs, especially in cases of sepsis, where timely initiation of antibiotics is crucial to reducing mortality.[17] However, the over-reliance on such antibiotics poses a significant risk for the development of antibiotic-resistant organisms. Studies have emphasized the need for culture-based

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antibiotic administration to reduce unnecessary exposure to broad-spectrum drugs.[18]

The relatively high use of last-line antibiotics, such as Polymyxin B (13%) and Vancomycin (13.6%), suggests the presence of multidrug-resistant organisms in the ICU. These findings align with global trends showing an increasing reliance on these agents due to the rise in resistant gram-negative bacteria.[18] Such widespread use of last-resort antibiotics highlights the urgent need for enhanced antibiotic stewardship in ICUs to prevent further resistance.

The most common pathogens isolated in this study were E. coli (30.8%), Staphylococcus (19.9%), and Klebsiella (18.1%), findings that are consistent with other ICU studies. In particular, gram-negative organisms like E. coli and Klebsiella are frequently responsible for hospital-acquired infections, particularly in ICUs where invasive procedures like catheterization are common.[16] The high prevalence of gram-negative bacteria in ICU settings is particularly concerning due to their increasing resistance to first-line antibiotics, necessitating the use of more toxic alternatives like Polymyxin B.

In terms of indications for antibiotic use, the majority of patients (58.2%) were treated for sepsis, which reflects the high burden of this condition in ICU settings. The global incidence of sepsis remains high, particularly in critically ill patients, and similar studies have reported sepsis as the leading cause of antibiotic prescriptions in ICUs.[17] The management of sepsis often involves empirical antibiotic use, which underscores the need for rapid diagnostics and culture results to tailor therapy and minimize the overuse of broad-spectrum antibiotics.

The high rates of resistance to Linezolid (29.2%), Vancomycin (25%), and Imipinem (20.8%) observed in this study are particularly concerning, as these antibiotics are often considered last-line therapies for serious infections caused by multidrug-resistant organisms. Resistance to these key antibiotics limits treatment options and has been reported in other studies focusing on ICU populations.[18] The resistance to Vancomycin and Linezolid is especially problematic for treating gram-positive infections like methicillin-resistant Staphylococcus aureus (MRSA), while resistance to Imipinem and other carbapenems complicates the treatment of gram-negative infections.

Interestingly, no resistance was observed for Doripinem and Ertapenem, which may indicate more prudent use of these antibiotics or limited exposure in the study population. Nevertheless, the growing resistance to carbapenems like Imipinem underscores the importance of judicious antibiotic use, particularly in ICUs where the emergence of resistant pathogens is more likely due to the heavy use of antibiotics.

Other studies have similarly highlighted the increasing challenge of antibiotic resistance in ICU settings. A recent meta-analysis noted that gender differences in sepsis outcomes, while present, are not always consistent across studies, with some reporting higher mortality rates in males and others finding no significant differences.[17] Furthermore, the global trend of rising resistance to broad-spectrum antibiotics, particularly in ICU settings, has been well-documented, with carbapenem-resistant Enterobacteriaceae and MRSA being common culprits.[18] These studies emphasize the need for rapid diagnostic tools to identify resistant organisms early and tailor antibiotic therapy accordingly.

CONCLUSION

The analysis of this study highlights a significant increase in the use of injectable restricted antibiotics at Ramachandra University, with Imipenem, Linezolid, Meropenem, and Vancomycin being the most commonly prescribed. Sepsis was the primary diagnosis among patients, leading to the frequent use of multiple restricted antibiotics. Alarmingly, many prescriptions did not adhere to World Health Organization (WHO) guidelines, indicating inappropriate use. E. coli emerged as the most common bacterial strain showing resistance in the hospital. Furthermore, morbidity was identified as a major factor affecting recovery outcomes for ICU patients. Based on these findings, it is recommended that steps be taken to promote the rational use of antibiotics to prevent the further development of resistance. This can be achieved by encouraging healthcare workers to strictly follow treatment guidelines and increasing the frequency of training sessions to improve prescribing practices. These measures will help optimize patient outcomes and curb the misuse of restricted antibiotics.

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