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PATTERN OF ANTIBIOTIC RESISTANCE OF BACTERIAL PATHOGENS IN PATIENTS ADMITTED IN MEDICINE ICU OF TERTIARY CARE CENTRE

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ABSTRACT

Introduction: Antimicrobial resistance (AMR) has emerged as a critical global health crisis, particularly affecting hospitalized patients in intensive care units (ICUs), where the use of broad-spectrum antibiotics is common and often empirical. The emergence of multidrug-resistant (MDR) organisms, including Escherichia coli, Klebsiella pneumonia, Pseudomonas aeruginosa, and methicillin-resistant Staphylococcus aureus (MRSA), has posed significant treatment challenges. In India, AMR is fuelled by inappropriate antibiotic use, lack of regulation, environmental contamination, and high patient density in healthcare facilities. Despite growing awareness, there remains a paucity of ICU-specific data, particularly from tertiary care centers. This study was therefore undertaken to evaluate the microbial profile, antibiotic resistance patterns, and demographic associations of infections among patients admitted to the Medicine ICU of a tertiary care hospital in Agra, India.

Objectives: To study the prevailing pattern of antibiotic resistance in bacterial pathogens among patients admitted to the Medicine ICU, of Tertiary Care Center Study the incidence of Nosocomial bacterial infections in patients admitted to the Medicine ICU, of Tertiary Care Centre. Study the Demographic pattern of the most frequently occurring bacterial infections, in patients admitted to the medicine ICU, in a Tertiary Care Center.

Methods: This was a prospective, observational, and analytical study conducted over 12 months (January 2023 to January 2024) in the Medicine ICU at S.N. Medical College and associated hospital,

Agra (U.P.), in collaboration with the Departments of Pharmacology and Microbiology. The study enrolled 140 patients aged over 18 years with either pre-existing or hospital-acquired (nosocomial) infections. Exclusion criteria included pregnancy, lactation, outpatient cases, and those already on empirical antibiotics before sample collection. Specimens such as urine, blood, sputum, pus, and stool were collected from each patient and sent for microbial culture and sensitivity testing. Data, including age, gender, infection type, organism isolated, and resistance/sensitivity profiles, were recorded and analyzed using Microsoft Excel.

Results: The Majority of patients were between 36 and 50 years and above 65 years. Out of 140 patients, the prevalence of ICU infections showed male predominance. The microbial Profile showed *Escherichia coli* as the most common organism, while urine and sputum were the most common specimens. Old infections showed predominance over Nosocomial infections.

Conclusion: This study revealed that Escherichia coli, Enterococcus spp, and Klebsiella pneumoniae were the predominant pathogens isolated from ICU patients, with urine being the most common source of infection. Antibiotic resistance was alarmingly high, especially to clindamycin, penicillin, and doxycycline, while Fosfomycin, Meropenem, and Ofloxacin showed relatively better efficacy. No statistically significant correlation was found between microbial distribution and either age or gender. The high prevalence of multidrug-resistant organisms, especially in nosocomial infections, underscores the need for stringent infection control policies, rational antibiotic prescribing practices, and regular antibiogram-based surveillance. This data provides a vital foundation for formulating local empirical antibiotic guidelines and implementing effective antibiotic stewardship programs in ICU settings.

Keywords: Intensive Care Unit, Hospital-Acquired Infections, Antibiotic Resistance, Multidrug-Resistant Organism,

Introduction:

The trend of epidemics has shifted from primarily infectious diseases to lifestyle-related conditions. Initially, antibiotics instilled a strong belief that infectious diseases would no longer pose a significant risk to individuals or society. However, this optimism was short-lived, as antibiotic-resistant infections began to emerge, presenting a serious challenge [1]. Bacteria develop resistance through various mechanisms, which have enabled them to survive over long periods. Resistance can be classified as intrinsic, acquired, or adaptive. Intrinsic resistance arises from the bacterial genetic structure and is passed down from parent to offspring, while acquired resistance occurs through either the horizontal transfer of resistance genes from other bacteria or genetic mutations. Like intrinsic resistance, acquired resistance is inheritable, with both types being stable and enduring.[2] The Global Burden of Disease (GBD) study attributed 7.7 million deaths to 33 *bacterial* diseases [3] The challenge of AMR in ICUs is amplified by the high consumption of antibiotics, and globally, antibiotic resistance poses serious health and economic threats [4]. Our tertiary care teaching hospital has lacked recent ICU nosocomial infection surveillance. Given that AMR patterns vary by region, hospital, and even individual ICUs, the objective of our study is to evaluate *bacterial* isolates from adult and pediatric ICU patients.[5] AMR is driven by unregulated usage [5]. Implementing antibiotic stewardship programs and maintaining local antibiograms is crucial for selecting effective empirical antibiotics, particularly in critical care settings [6] Escherichia coli isolates from hospital waste showed 95% resistance to third-generation cephalosporin, compared to 25% from domestic waste, risk factors include the use of invasive devices, immunosuppressant, and empirical antimicrobial therapy. Empirical therapy is common due to critical conditions and delayed culture results.[8]

Material and Methods: A 12-month Study was conducted in the ICU of the Department of Medicine in collaboration with the Department of Pharmacology and Therapeutics with the Department of Microbiology during a period from January 2023- January 2024 at S.N. Medical College and associated hospital, Agra (U.P.).

The study was approved by the scientific review board and institutional ethics committee.

Patients diagnosed with infectious diseases will be enrolled and analyzed under demographic data, antibiotic sensitivity patterns, and causative microbial pathogens.
There are no apparent risks of the study and the benefits can be assessed by measuring the rate of hospital admission and mortality.

Study Design:
It is an observational, prospective, and analytical study.

Inclusion Criteria:
1. Adult Patients who have an already established diagnosis of an infection before admission into the hospital
2. Adult patients selected by non-random consecutive sampling technique with age more than 18 years and diagnosed with at least one hospital-acquired (nosocomial) infection such as hospital-acquired pneumonia (HAP), Ventilator-associated pneumonia (VAP) urinary tract infection (UTI), Bloodstream infections (BSIs), catheter-related bloodstream infections (CRBSIs), Intra-Abdominal infections (IAIs) and skin & skin soft tissue infections (SSTIs) etc.

Exclusion Criteria:
1. Outpatients
2. Pregnancy & lactation
3. Patient who started empirical antibiotics before collecting specimens.

Data Collection:
Patients were enrolled from those diagnosed with infections at the ICU of Medicine department of S.N. Medical College, Agra.
1. Details of the patient: Age, Sex, Diagnosis during the stay period in Medicine ICU.
2. Culture and sensitivity report of the causative microbe.

Result:

Table 1: Age-wise Distribution of study participants.

		Number	Percentage
Age intervals	18-35 years	22	15.7%
	36-50 years	61	43.6%
	51-65 years	44	31.4%
	Above 65 years	13	9.3%
	Total	140	100.0%

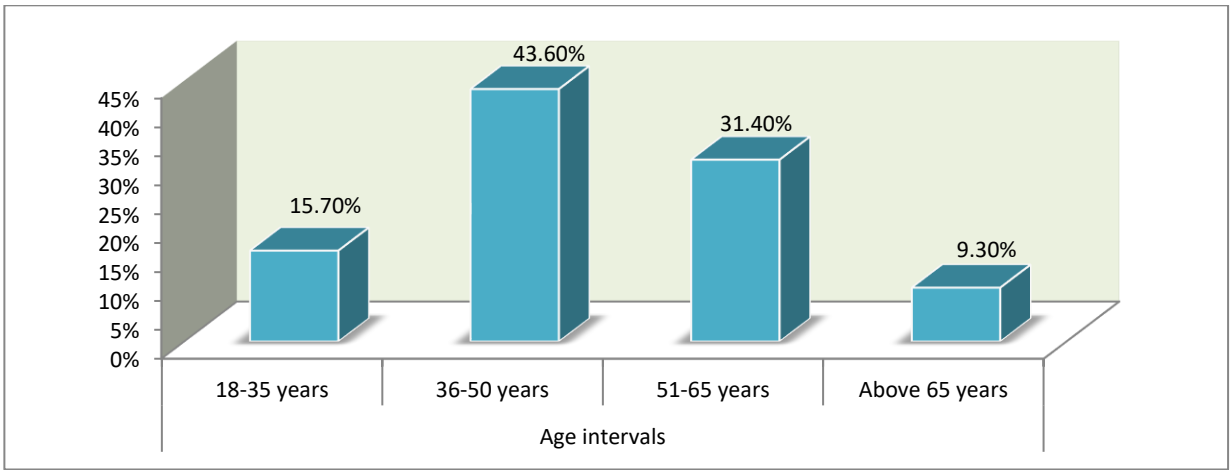

Figure 1: Age-wise Distribution of study participants.

The mean age of the patients was 48.51±12.56 years, with a median of 49 years. The age ranged from 18 to 79 years. A total of 140 patients were included in the study.
The majority of patients belonged to the 36–50 year age group [61 (43.6%)], followed by those aged 51–65 years [44 (31.4%)], and 18–35 years [22 (15.7%)]. Only 13 (9.3%) patients were above 65 years of age.

Table 2: Gender-wise Distribution of Study Participants

Males comprised a higher proportion of the study population [86 (61.4%)] compared to females [54 (38.6%)].

		Number	Percentage
Sex	Female	54	38.6%
	Male	86	61.4%
	Total	140	100.0%

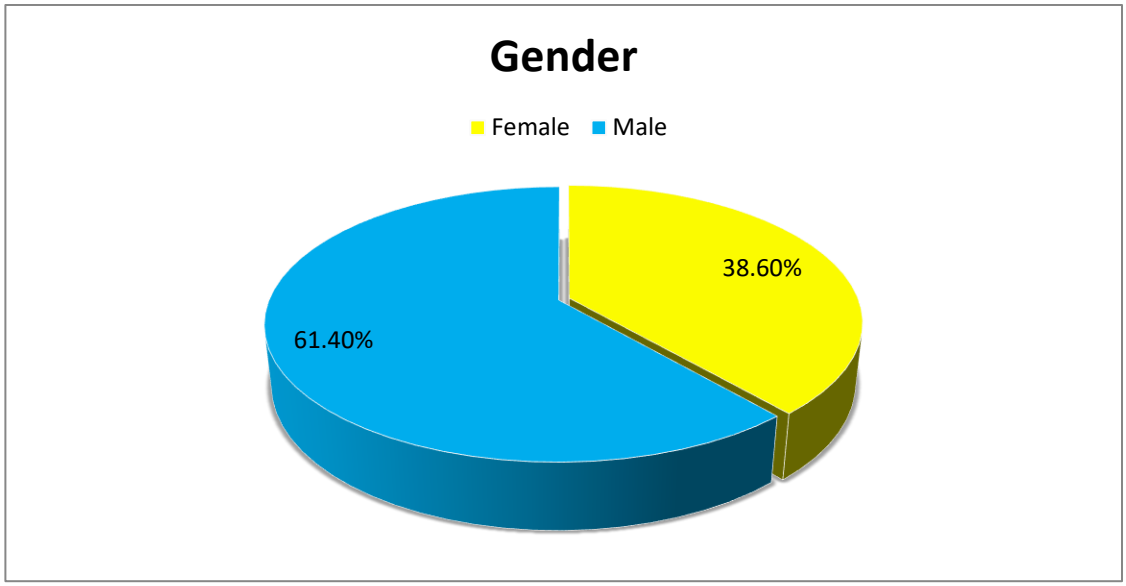

Figure 2: Gender-wise Distribution of study participants

Table 3: Distribution of isolated microbial organisms.

Microbe	Number	Percentage
Compylobacter rosier	2	1.4%
Escherichia coli	44	31.4%
Enterobacter species	30	21.4%
Klebsiella oxytoca	10	7.1%
Klebsiella pneumoniae	25	17.9%
Klebsiella species	4	2.9%
Proteus mirabilis	4	2.9%
Pseudomonas species	4	2.9%
Pseudomonas aeruginosa	2	1.4%
Staphylococcus aureus	9	6.4%
Staphylococcus species	6	4.3%
Total	140	100.0%

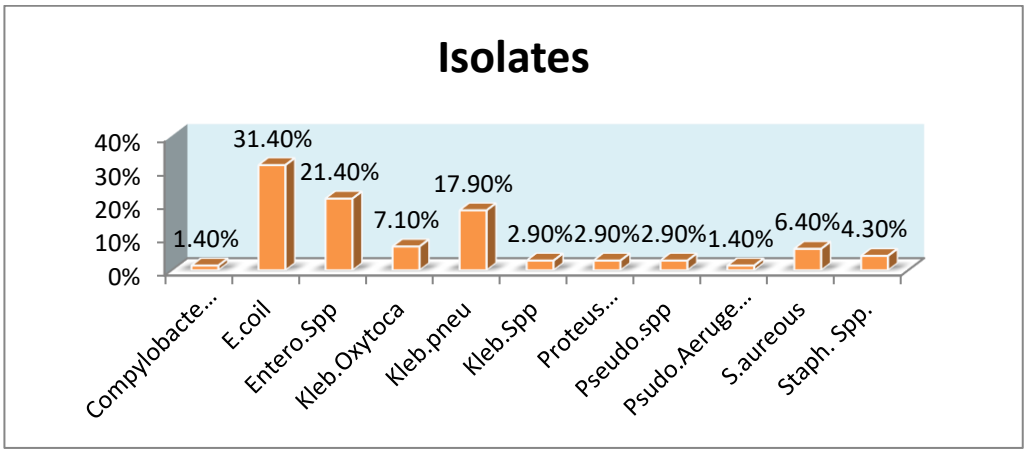

Figure 3: Distribution of isolated microbial organisms

Among the isolated organisms, Escherichia coli was the most frequently identified microbe, detected in 44 (31.4%) cases. This was followed by Enterococcus species in 30 (21.4%) cases and Klebsiella pneumoniae in 25 (17.9%) patients. Other notable isolates included Klebsiella oxytoca [10 (7.1%)], Staphylococcus aureus [9 (6.4%)], and Staphylococcus species [6 (4.3%)]. Less commonly isolated organisms were Klebsiella species [4 (2.9%)], Proteus mirabilis [4 (2.9%)], Pseudomonas species [4 (2.9%)], Campylobacter rosier [2 (1.4%)], and Pseudomonas aeruginosa [2 (1.4%)].

Table 4: Distribution of various specimen types.

		Number	Percentage
Specimen	Blood	23	16.4%
	Pus	14	10.0%
	Sputum	26	18.6%
	Stool	2	1.4%
	Urine	75	53.6%
	Total	140	100.0%

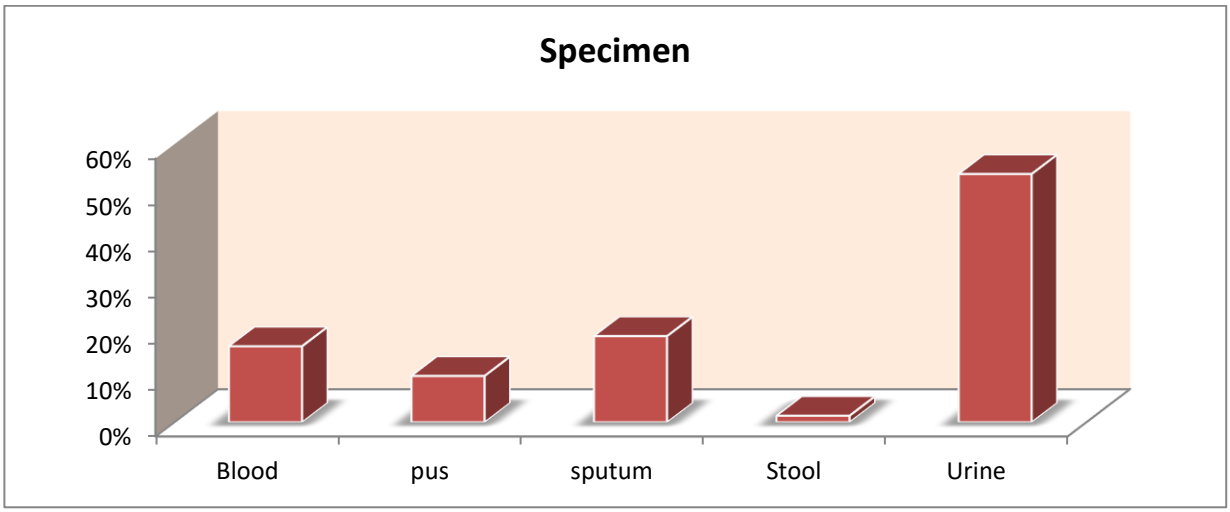

Figure 4: Distribution of various specimen types.

Urine was the most common specimen type collected, accounting for 75 (53.6%) of the samples. This was followed by sputum in 26 (18.6%) cases and blood in 23 (16.4%) cases. Pus samples were obtained from 14 (10%) patients, while stool was the least common, collected in only 2 (1.4%) cases.

Table 5: Sensitivity and resistance pattern of various antibiotics.

		Number	Percentage
Tetracycline	R	91	65.0%
	S	49	35.0%
	Total	140	100.0%
Linezolid	R	85	60.7%
	S	55	39.3%
	Total	140	100.0%
Vancomycin	R	104	74.3%
	S	36	25.7%
	Total	140	100.0%
Amoxycillin+Clavulanic Acid	R	75	53.6%
	S	65	46.4%
	Total	140	100.0%
Erythromycin	R	106	75.7%
	S	34	24.3%
	Total	140	100.0%
Gentamicin	R	111	79.3%
	S	29	20.7%
	Total	140	100.0%
Ofloxacin	R	67	47.9%
	S	73	52.1%
	Total	140	100.0%
Teicoplanin	R	114	81.4%
	S	26	18.6%
	Total	140	100.0%
Fosfomycin	R	58	41.4%
	S	82	58.6%
	Total	140	100.0%
Clindamycin	R	130	92.9%
	S	10	7.1%
	Total	140	100.0%
Penicillin	R	124	88.6%
	S	16	11.4%
	Total	140	100.0%
Doxycycline	R	122	87.1%
	S	18	12.9%
	Total	140	100.0%
Cotrimoxazole	R	115	82.1%
	S	25	17.9%
	Total	140	100.0%
Colistin	R	102	72.9%
	S	38	27.1%
	Total	140	100.0%
Amikacin	R	103	73.6%
	S	37	26.4%
	Total	140	100.0%
Meropenem	R	63	45.0%

	S	77	55.0%
	Total	140	100.0%
Aztreonam	R	91	65.0%
	S	49	35.0%
	Total	140	100.0%
Ciprofloxacin	R	112	80.0%
	S	28	20.0%
	Total	140	100.0%
Piperacillin+Tazobactam	R	72	51.4%
	S	68	48.6%
	Total	140	100.0%
Polymixin-B	R	105	75.0%
	S	35	25.0%
	Total	140	100.0%
Cefixime	R	117	83.6%
	S	23	16.4%
	Total	140	100.0%
Ceftazidime	R	114	81.4%
	S	26	18.6%
	Total	140	100.0%
Ampicillin+Sulbactam	R	104	74.3%
	S	36	25.7%
	Total	140	100.0%
Nitrofurantoin	R	75	53.6%
	S	65	46.4%
	Total	140	100.0%
Chloramphenicol	R	79	56.4%
	S	61	43.6%
	Total	140	100.0%

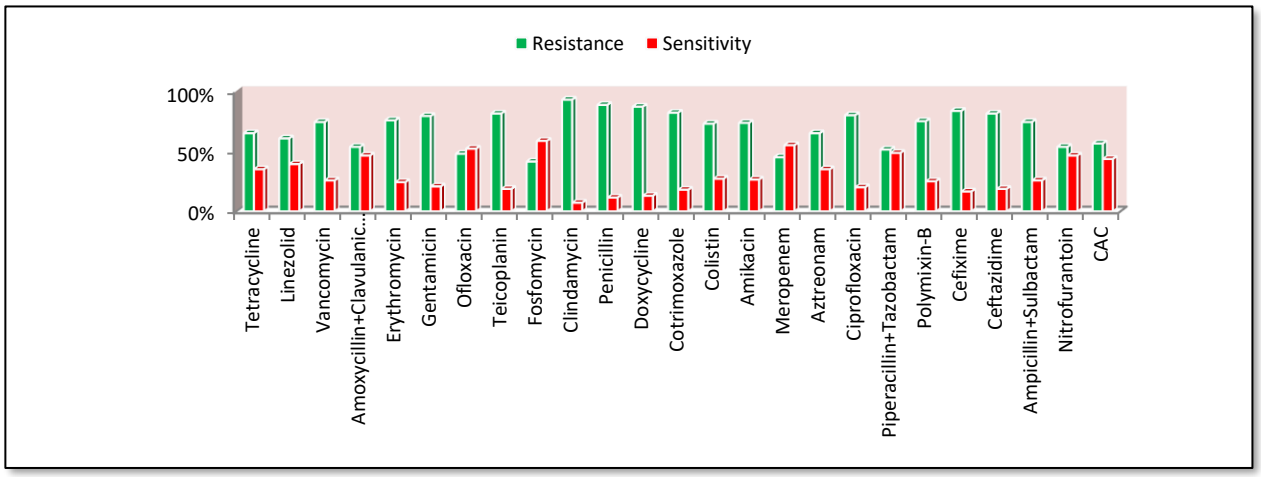

Figure 5: Sensitivity and resistance pattern of various antibiotics.

Resistance percentage was highest for clindamycin [130 (92.9%)], penicillin [124 (88.6%)], and doxycycline [122 (7.1%)]. Cotrimoxazole [115 (82.1%)], ceftazidime [114 (81.4%)], teicoplanin [114 (81.4%)], and ciprofloxacin [112 (80%)] also showed high resistance rates. Gentamicin resistance was seen in 111 (79.3%) cases.

Moderate resistance percentage was noted for vancomycin and ampicillin-sulbactam [104 (74.3%) each], amikacin [103 (73.6%)], colistin [102 (72.9%)], and erythromycin [106 (75.7%)]. Aztreonam and tetracycline showed resistance in 91 (65%) cases, while Chloramphenicol was resistant in 79 (56.4%).
A lower resistance percentage was observed with piperacillin-tazobactam [72 (51.4%)], ofloxacin [67 (47.9%)], and fosfomycin [58 (41.4%)]. The least resistance was seen with meropenem [63 (45%)], nitrofurantoin, and amoxicillin-clavulanic acid [75 (53.6%) each].

Table 6: Status of old and nosocomial infections in the hospital.

Infection status	Number	Percentage
Old infections	117	83.57%
Nosocomial infections	23	16.43%
Total	140	100.0%

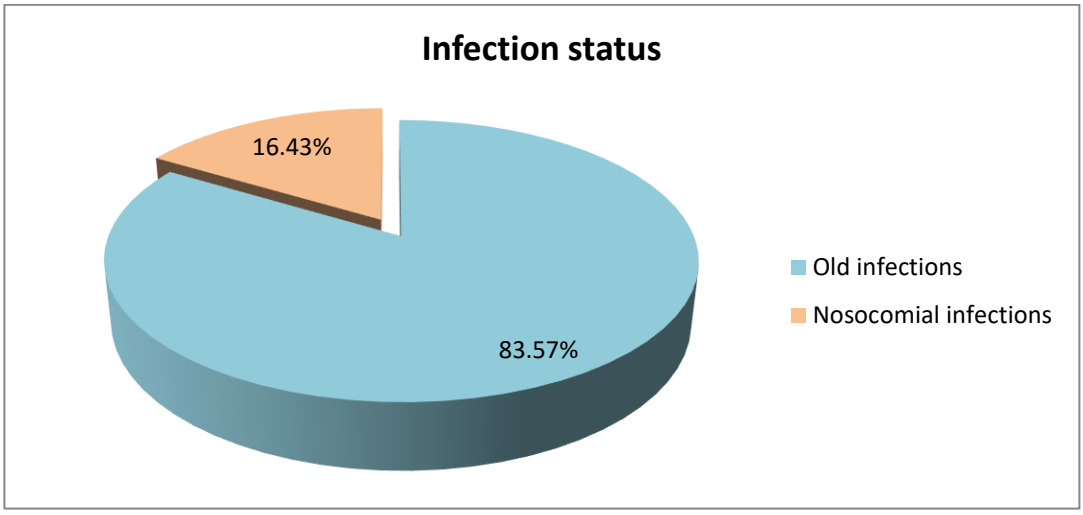

Figure 6: Status of old and nosocomial infections in the hospital

There were 117 (83.57%) old infections identified before admission to the hospital and 23 (16.43%) were nosocomial infections.

Discussion

In clinical settings, the management of infectious diseases is often initiated empirically, to a more targeted therapy once culture and sensitivity results are available. The present study highlights the prevailing trends in bacterial prevalence, specimen types, and antimicrobial susceptibility among ICU patients, offering valuable insights into the current resistance landscape. While empirical therapy remains a practical necessity in critical care, the observed patterns emphasize the pressing need for culture-based, evidence-driven antibiotic selection.
Our findings support the growing concern about antibiotic overuse and misuse, which contribute to adverse drug reactions, rising antimicrobial resistance (AMR), prolonged hospital stays, and increased healthcare costs. In this context, drug utilization studies such as ours serve as critical tools in assessing prescribing behavior, informing healthcare providers, and providing feedback for continuous improvement of antimicrobial practices. These studies are intended to educate clinicians and support stewardship efforts rather than impose punitive oversight.
The increasing prevalence of MDR bacteria across all specimen types, particularly among *E. coli* and *K.* pneumoniae, aligns with global concerns about resistance in ICU settings. Broad-spectrum and reserve antibiotics must be used judiciously, and treatment protocols should align with established local and national guidelines for infectious disease management. Ultimately, the findings underscore the critical role of antibiotic stewardship, surveillance, and continuous education in combating AMR.

It is important to note that this study does not aim to evaluate the clinical appropriateness of antimicrobial use against existing treatment guidelines. Rather, it provides a microbiological snapshot that may serve as a foundation for future interventional studies and policy formulation to improve rational antibiotic use in tertiary care settings.

Conclusion: This study was conducted to determine the prevalence of infectious diseases, the effect of gender and age on its prevalence and their susceptibility profile in the community.
This study aims to provide valuable quality data to monitor the status of antimicrobial resistance among common bacterial pathogens in the ICU of the Medicine Department of S.N. Medical College, Agra.
It is evident from the present study that, for infectious diseases, when seen overall, the antibiotics found with greatest sensitivity are Fosfomycin (58.6%), Meropenem (55.0%), Ofloxacin(52.1%), Piperacillin+ Tazobactam(48.6%), Nitrofurantoin(46.4%), Amoxycillin+ Clavulanic acid(46.4%), Chloramphenicol(43.6%), Linezolid (39.3%), Aztreonam(35.0%).
The majority of patients were between 36–50 years, followed by 51–65 years. Out of 140 patients,61.4% were males whereas 38.6% were female, showing a male predominance.
Amongst the isolated microbes, Escherichia coli and Enterococcus spp were the most frequently occurring microbes in ICU patients, both occurring most commonly in Urine specimens.
Amongst antibiotics used in the ICU patients Highest resistance was observed for Clindamycin(92.9%) and Penicillin(88.6%).Bacterial resistance observed for Vancomycin(74.3%), Amikacin(73.6%) and Erythomycin(75.7%) was of moderate intensity whereas lowest resistance was observed for ofloxacin(47.9%), Fosfomycin(41.4%), and meropenem(45%)-best sensitivity overall.
E. coli was most prevalent in the 36–50 age group (36.1%) and among those above 65 years (38.5%).Enterococcus spp. showed a uniform distribution across all age groups. Klebsiella pneumoniae was more common among younger adults.
The highest sensitivity (100%) was observed in Proteus mirabilis, P. aeruginosa, Pseudomonas spp., Staphylococcus aureus, and Staphylococcus spp. Escherichia coli showed excellent sensitivity to ofloxacin, fosfomycin, meropenem, and piperacillin-tazobactam (43/44, 97.7%). Klebsiella pneumoniae was highly sensitive only to meropenem (100%) and fosfomycin (96%). Enterococcus spp. showed full sensitivity to linezolid and amoxicillin-clavulanic acid (100%).
Of a total of 140 patients the data relating old with nosocomial infections indicated that 1 in every 5 patients admitted to ICU was prone to Hospital-acquired infections [old infections N=117 cases (83.57%) Nosocomial infections N=23 cases (16.43%)].

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