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# PATTERN OF BACTERIAL ISOLATES SUSCEPTIBILITY TO ANTIBIOTICS IN THE INTENSIVE CARE UNIT: A CROSS-SECTIONAL STUDY.

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## Abstract

### Background

Infection control has been a major problem for the past two decades due to the rapid emergence of antimicrobial resistance (AMR). Most antibiotic resistance develops in intensive care units. Due to antimicrobial resistance management of infectious diseases becomes a challenge, and physicians need antibiograms with recent updates to develop a treatment plan for the patients.

### Aim

To study the antibiogram of isolated bacterial culture from the intensive care unit.

### Materials and Methods

A retrospective study was conducted from October 2021 to April 2023. A total of 150 patients' samples, received from various ICUs, were processed according to the standard protocol. Various specimen types were aseptically collected and sent to the NMCH Microbiology Laboratory. Antibiotic susceptibility tests followed the Kirby-Bauer disk diffusion method. Statistical analysis was performed using SPSS, with significance set at $P<0.05$.

### Results

The study included patients aged 0 to 85 years, most admissions were in the Surgical ICU (47.1%), primarily with pus (30.6%) and blood samples (25.3%). Among 85 samples with bacterial growth, 56.66% were Gram-negative bacilli, with *Pseudomonas* spp. (15.69%) as the leading isolate. Gram-positive organisms (43.13%) included Methicillin-resistant *Staphylococcus aureus* (15.69%). Pseudomonas was highly sensitive to Colistin (100%) but resistant to Ceftazidime and Tetracycline. MRSA showed sensitivity to Vancomycin and Linezolid but resistance to Cefoxitin, Tetracycline, and Levofloxacin.

### Conclusion

This study highlights the importance of antimicrobial resistance in intensive care units, where most antibiotic resistance arises. The prevalence of multidrug-resistant Gram-negative bacilli like *Pseudomonas* spp. and MRSA is alarming. Sensitivity patterns show standard antibiotics' low efficiency against certain bacteria. The findings highlight the need for updated and personalized antibiograms to guide ICU treatment methods, where AMR makes infectious illness management difficult.

### Recommendation

Screening of the admitted patients can help generate the data and develop a plan which can effectively treat nosocomial infections.

***Keywords:*** *Antibiogram, Intensive Care Unit, Multidrug Resistance, Pseudomonas spp., Methicillin-resistant Staphylococcus aureus*
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## Introduction

Infections acquired in the hospital are known as nosocomial infection or health-related infections, has the most effect on public health [1, 2]. Patients in intensive care units (ICUs) often have low immunity, which

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could be due to weakened immune system due to disease and other invasive processes that further deteriorate the immunity. The patients admitted to the ICU are prone to infections. There is a risk of having a disease secondary to the existing disease because the good microorganisms are also killed by the use of broad-spectrum antibiotics [3-5].

Nosocomial infections are usually caused by resistant organisms which have resistance towards multiple antimicrobials [6]. Multi-drug resistant strains (MDR) are those that are resistant towards more than 3 antimicrobials [7]. Antimicrobial resistance is quite prevalent and there are many multi-drug resistant strains now. Patients infected with multi-drug resistant bacteria are difficult to treat as they have a limited number of drugs that can be effective [8, 9]. Treating multi-drug resistant infection is not the only problem, but the spread of this infection in a hospital unit can lead to uncontrollable infection [10]. The number of instances of resistant infection can increase with the increase in the number of days of hospitalization and increase the rate of mortality [11, 12].

There can be multiple reasons for multi-drug-resistant bacteria. This results from improper use of antibiotics [13]. The resistant organisms are increasing exponentially but the frequency and patterns are varying with respect to geographical regions [13, 14]. This underscores the need for appropriate local data to predict the type of resistance and direct the choice of antimicrobials in the event of disease [15]. The development of appropriate antibiotic stewardship requires an understanding of the pathogens and their sensitivity [16]. The aim of this study was to determine the multi-drug resistant bacteria in the Intensive care unit and determine the disease it can lead to**.**

## Materials and Methods

### Study Design

A retrospective cross-sectional study was conducted.

### Study setting

From October 2021 to April 2023 to in the Department of Microbiology of Nalanda Medical College in Jamuhar, Sasaram, Bihar, India, a total of 150 samples of isolated bacteria was taken from the hospitals.

### Sampling procedure

Diagnosis of the patients was done on the basis of the symptoms, and the clinical history was studied in terms of the number of days of hospital stay, invasive procedures, and medical conditions. The diagnosis and investigations were carried out according to the appropriate regional guidelines and regulations, and all data was extracted from the laboratory register and medical record department (MRD) of the hospital.

### Bias

The potential for bias to manifest during the initial stages of the study was acknowledged. However, this was reduced by ensuring that all participants received uniform information and by concealing the group allocation from the data-collecting nurses.

### Selection criteria

Appropriate specimens like blood, pus swabs, body fluids, tissues, and endotracheal tubes and aspirates were considered in this study and were collected aseptically and sent to the Department of Microbiology Laboratory of NMCH, Jamuhar, India.

### Laboratory methods

All samples were inoculated on solid media like MacConkey agar plates and blood agar plates and incubated aerobically at 37°C overnight. In culture-positive (bacterial growth) plates identification was done by colony morphology, Gram staining, and biochemical reactions as per standard protocol. Antibiotic susceptibility tests were done by the Kirby-Bauer disk diffusion method.

### Bias

There was a chance that bias would arise when the study first started, but we avoided it by giving all participants the identical information and hiding the group allocation from the nurses who collected the data.

### Ethical consideration

The institutional ethics committee gave its approval for this study.

### Statistical analysis

Data entry was performed by transferring information from the case record into the Microsoft Excel 2010 program. Descriptive statistics were employed to present the demographic characteristics, infection rate, isolation pattern of diverse organisms, their antibiogram, and the prescription pattern of antimicrobial agents.

## Results

### 1. Demographic of patients

The patients had ages ranging from 0 to 85 years. The average age of the patients was 43 years. The majority of the patients were from the 21 to 40 age group, followed by the 41–60 age group. Male patients were 57 (67%), and female patients were 28 (33%).

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**Fig 1 illustrated that out of the total 150 samples, 85 showed growth.**

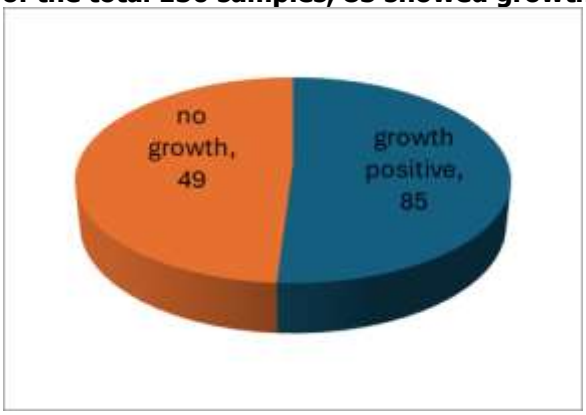


*Fig 1- Sample Distribution*

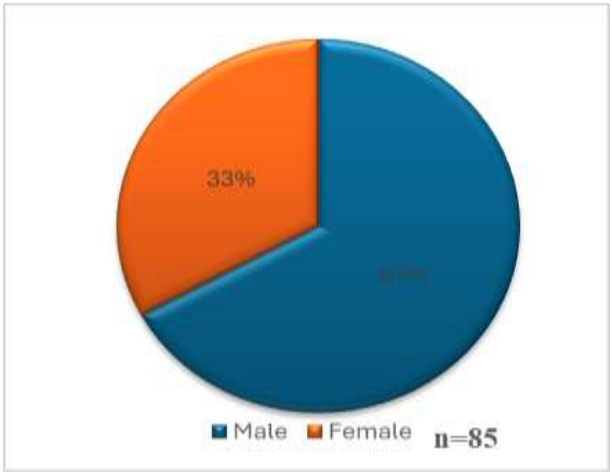


*Figure 2: Gender distribution of patients*

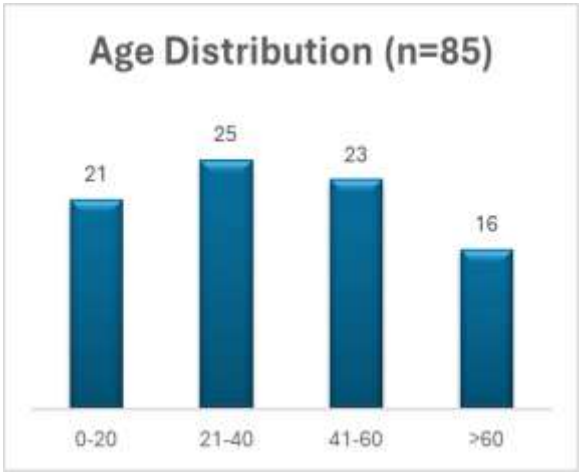


*Figure 3: Age distribution of patients*

## Types of ICU & Samples Collected

Maximum patients were admitted in Surgical ICU 40 (47.1%) with a maximum of Pus samples collected 46 (30.6%) followed by Blood samples 38 (25.3%). Maximum samples showing positive growth were pus swabs (28) and isolated maximally from patients admitted to SICU (40), followed by PICU (9) (Table 1).

**Table 1: Distribution of Samples with ICU**

| Type of ICU | ET Tube/Secretions (n=15) | Pus swab (n=46) | Body Fluid (n=8) | Tissue (n=7) | Blood (n=38) | CSF (n=6) | Urine (n=30) | **Total (n=150)** |
|---|---|---|---|---|---|---|---|---|
| MICU | 9 | 0 | 2 | 0 | 6 | 2 | 5 | **24** |
| SICU | 1 | 25 | 1 | 3 | 1 | 0 | 9 | **40** |
| NICU | 0 | 0 | 0 | 0 | 8 | 0 | 0 | **8** |
| PICU | 0 | 3 | 0 | 0 | 4 | 1 | 1 | **9** |
| CICU | 0 | 0 | 1 | 0 | 1 | 0 | 2 | **4** |
| **TOTAL** | **10** | **28** | **4** | **3** | **20** | **3** | **17** | **85** |

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## Organisms Isolated

A total of 85 samples showing bacterial growth, 48 (56.66%) were Gram-negative bacilli of which *Pseudomonas spp 8 (15.691%),* was the most common isolate followed by *Escherichia coli, including ESBL E. coli,* 7(13.71%), *Klebsiella spp 6(11.76%), Citrobacter spp 5(9.80%), Acinetobacter 3(5.88%) and* 22 (43.13%) Gram-positive organisms were isolated of which 8(15.69%). Methicillin resistance *Staphylococcus aureus* followed by Methicillin sensitive *Staphylococcus aureus* 7 (13.73%), CONS 5 (9.80%) & *Enterococcus* 2 (3.92%) (Figure 4).

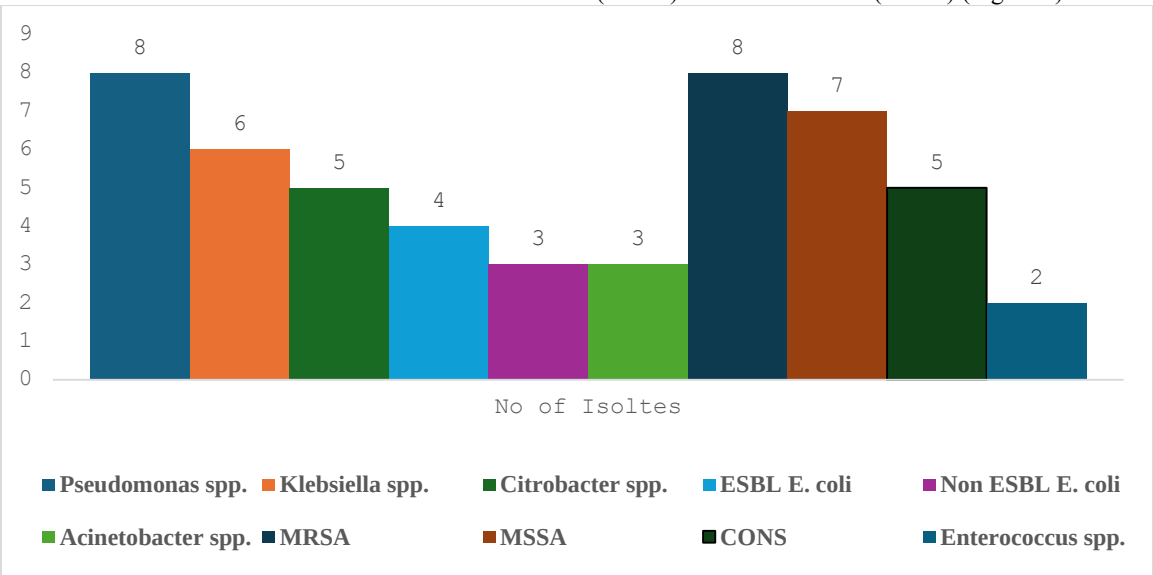


*Figure 4: Organism Isolated from various samples*

## Antibiotic resistance profile of pathogens isolated

Most of the isolated organisms in our study were less sensitive to the 1st (fluoroquinolones and gentamicin) and 2nd (carbapenams) lines of antibiotics, whereas they were more sensitive to the 3rd line(cephalosporins) of antibiotics, which indicates the emergence of multidrug-resistant organisms.

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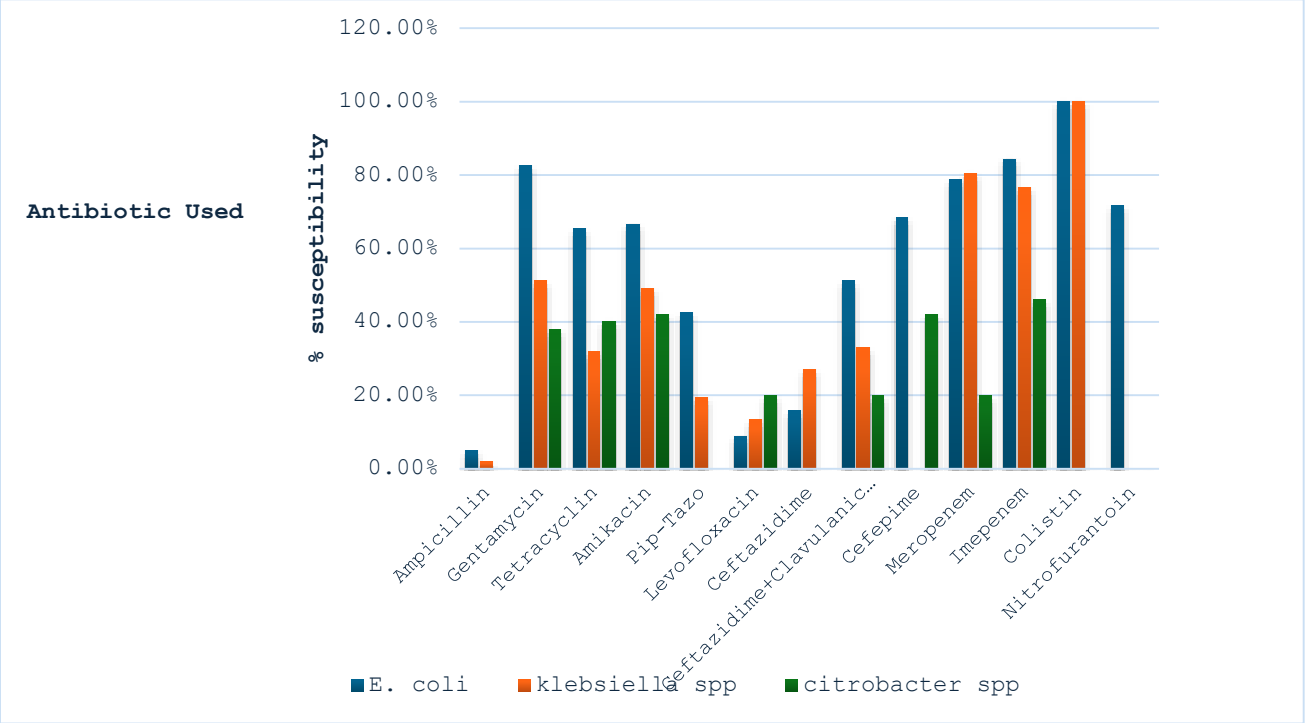


*Fig 5- Antibiogram of Enterobacteriaceae*

**Fig 5** shows that maximum sensitivity was for Colistin (100%) while maximum resistance seen for Ampicillin followed by Levofloxacin.

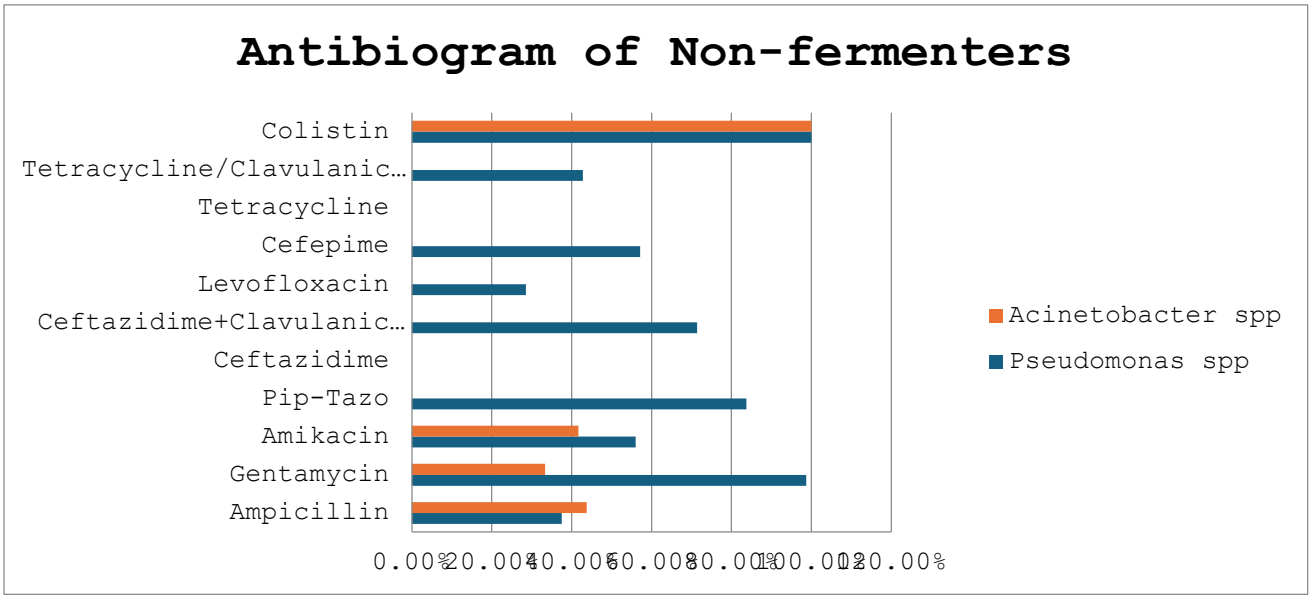


*Fig 6- Antibiogram of Non- Fermenters*

Fig 6 shows, *Pseudomonas* was maximum sensitive for Colistin (100%) followed by Gentamycin while 100% resistance showed against Ceftazidime and Tetracycline.

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*Acinetobacter* also showed 100% sensitivity for Colistin followed by Ampicillin (37.5%) while 100% resistance was for Ceftazidime and Tetracycline.

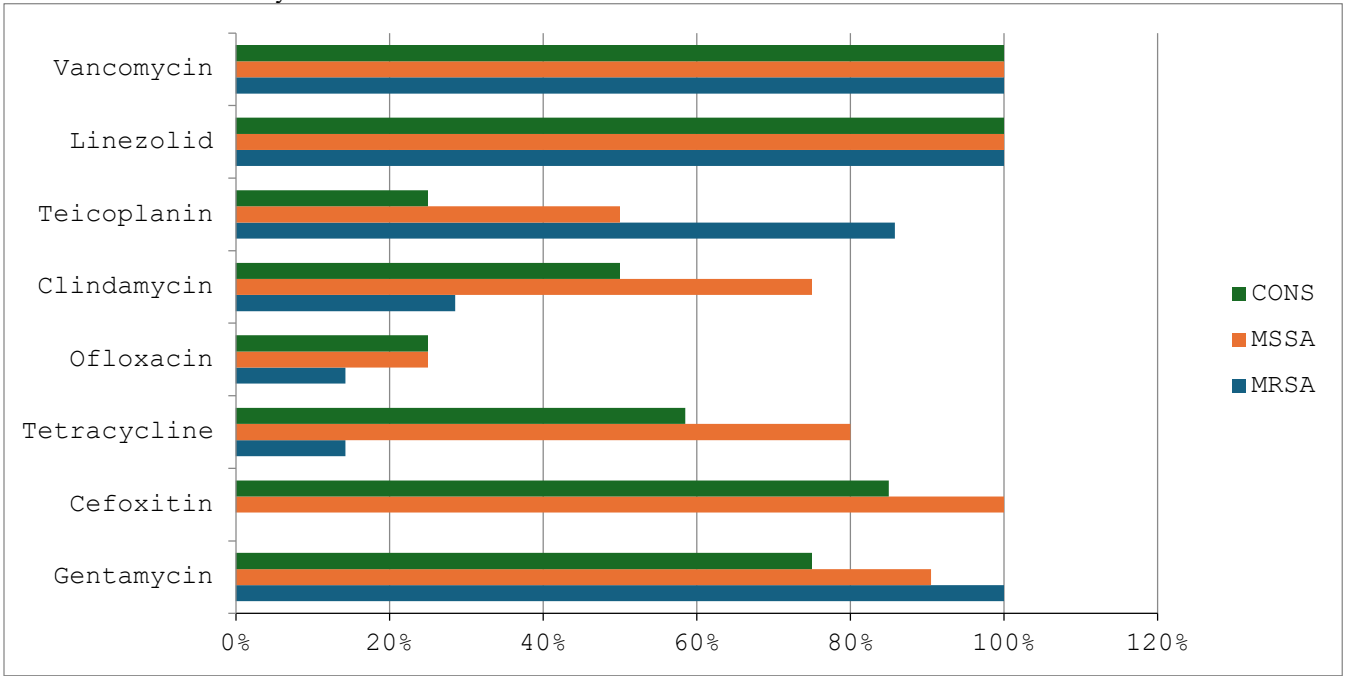


*Fig 7- Antibiogram of Gram-positive cocci*

Fig 7 shows samples showing growth for Methicillin sensitive *Staphylococcus aureus* were 100% sensitive for Vancomycin, followed by Linezolid and cefoxitin. 100% resistance was seen for Ofloxacin followed by Teicoplanin. Methicillin resistant *Staphylococcus aureus* were 100% sensitive for Vancomycin and Linezolid followed by

Gentamycin while 100% resistance was seen for Cefoxitin followed by Tetracycline (14%) and Levofloxacin.

## Discussion

In our study, it was found that 56.7% of the patients in the ICU were infected. This finding was consistent with the other study which found 54.7% of the patients infected [17]. The remaining 44.44% did not have infection. This might have occurred due to the use of broad-spectrum antibiotics among those patients. The other possible reason could be improper bacterial growth in the laboratory [18].

In this study, of all 85 bacterial isolates, Gram-negative bacteria are more significantly causing infections (29, 56.66%) than Gram-positive bacteria (22, 43.33%). This proliferation of Gram-negative bacteria coincided with the discovery of other studies [19, 20]. Gram-negative bacteria are widespread, and they are prevalent in the hospital environment, and most of them are common normal flora. In addition, their constant resistance to antibiotics may contribute to their persistence and spread. Similar to this study, *Pseudomonas aeruginosa* was reported to be the predominant organism in ICU isolates in other studies [21, 22]. Although the frequency of such occurrence varied among other studies [22, 23].

The incidence of antibiotic-resistant bacteria in our research population was substantial. The presence of multi-drug-resistant microorganisms in hospitals is a significant cause for worry [14]. The proliferation of drug-resistant bacteria inside hospitals has led to significant and unwarranted use of antibiotics and therapeutic interventions for these diseases [17]. The situation is more severe in the intensive care unit (ICU) due to excessive usage of antibiotics, which therefore impacts the result of patients' hospitalization [11, 13].

In our investigation, the most prevalent organisms isolated from ICU patients were gram-negative isolates such as *Acinetobacter, E. coli, Proteus*, and *Klebsiella* which showed resistance to cephalosporins, piperacillin, and tozabactum. Empirical antibiotic therapy has relied on Piperacillin-tazobactam, with carbapenems added for severely ill ICU patients. Additionally, the Indian Council of Medical Research (ICMR) advises treating critically sick patients empirically with β-lactam antibiotics combined

with β-lactamase inhibitors, such as Piperacillin-tazobactam [23].

Significant resistance to tazobactam and piperacillin was seen in both gram-negative and gram-positive infections, according to the acquired culture and sensitivity data. Over the past ten years, Enterobacteriaceae that are resistant to carbapenem, such as *Klebsiella, E. coli*, and *Acinetobacter*, have become more common, which is analogous to our finding [24]. Since we are a tertiary care hospital, patients may come in with severe sepsis and septic shock as a result of previous antibiotic use, prior severe gram-negative infections, and inappropriate antibiotic courses.

Older drugs like colistin have been effective due to the rise of microbes' resistance to many drugs. In our investigation, colistin sensitivity persisted in gram-negative isolates. We did find, however, a small number of isolates in our investigation that were pan-drug resistant- that is, resistant to every medication. The threat posed by the emergence of these multidrug-resistant microbes to humankind makes us wonder what comes next.

To improve treatment with nosocomial infections physicians, need to make decisions on the basis of recent trends in the bacterial isolates of the intensive care units. Antibiograms can help physicians in prescribing effective drugs. The most crucial aspect of this is minimizing collateral damage to present and future patients by using vigorous de-escalation strategies in conjunction with broad-spectrum empirical antimicrobials. To decrease the risk of nosocomial infections and improve patient response and clinical outcomes, emphasis should also be placed on the use of sterile methods during device insertion, hand cleanliness, and gown and glove use in the ICU.

## Conclusion

Our analysis reveals that the majority of the isolated organisms had reduced sensitivity to the first (fluoroquinolones and gentamicin) and second (carbapenams) lines of antibiotics while demonstrating maximum sensitivity to the third line (cephalosporins) of antibiotics. This suggests the establishment of multidrug-resistant organisms, which might have a negative impact on a patient's prognosis. This shows that there is a need for continuous cooperation among intensive care unit (ICU) healthcare personnel, medical microbiology experts, and the infection control team while providing treatment for these patients. Enhancing healthcare spending and ensuring strict adherence to infection control protocols is a strategic approach to enhance existing healthcare preventative efforts.

## Limitation

The variability of antibiotic disc sensitivity test results within a hospital setting is a recognized phenomenon. It is important to acknowledge that the infection rate within a hospital is contingent upon various factors, including the hospital environment, antibiotic utilization, and implementation of infection control measures. The aforementioned factors may impose constraints on the generalizability of the conclusions drawn from this study to alternative healthcare environments.

## Recommendation

Screening of the admitted patients can help generate the data and develop a plan which can effectively treat nosocomial infections.

## Acknowledgement

We are grateful to the hospital's staff and patients involved in the study for their cooperation during the study.

## List of abbreviations

ICU- intensive care unit
AMR- Antimicrobial resistance
MICU- medical intensive care unit
MRSA- Methicillin-resistant *Staphylococcus aureus*
ESBL- Extended spectrum beta-lactamases
SICU- surgical intensive care unit
CICU-cardiac intensive care unit
PICU-pediatric intensive care unit
NICU-neonatal intensive care unit
CSF-cerebrospinal fluid
MDR- Multi drug resistant
MRD- Medical record department
CONS- Coagulase-negative Staphylococci

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## Conflict of interest

No Conflict of interest

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