

Antibiogram of Bacterial Isolates from Critical Care Patients in Sharda Hospital - A Tertiary Care Hospital

by Jana Publication & Research

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Antibiogram of Bacterial Isolates from Critical Care Patients in Sharda Hospital - A Tertiary Care Hospital

¹⁹
Abstract

Background:

Antimicrobial resistance (AMR) poses a major threat to global public health, particularly in developing nations with high infection burdens and widespread antibiotic misuse. Intensive Care Units (ICUs) are critical sites for the emergence and transmission of multidrug-resistant (MDR) organisms, with critically ill patients at increased risk due to invasive procedures and compromised immunity. ESKAPE pathogens and other Gram-negative bacteria are frequently

implicated in ICU infections, complicating empirical treatment and contributing to adverse outcomes. Despite this, there is limited surveillance data on resistance trends in ICUs, especially in low- and middle-income countries like India.

Materials and Methods:

A hospital-based cross-sectional observational study was conducted over six months (October 2023- March 2024) in the Department of Microbiology, Sharda Hospital, Greater Noida. Clinical samples from ICU patients including blood, urine, respiratory secretions, and pus—were processed using standard microbiological techniques. Bacterial identification involved Gram staining, colony morphology, and biochemical testing. Antimicrobial susceptibility testing (AST) was carried out using the Kirby-Bauer disc diffusion method, interpreted as per CLSI 2023 guidelines.

Results:

A total of 2,125 ICU samples were analyzed, including blood (46%), urine (30%), respiratory samples (20%), and pus (4%). From these, 285 clinical isolates were recovered: respiratory samples yielded the highest proportion (46%), followed by blood (23%), urine (20%), and pus (11%). The most common isolates included *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*, and *Enterococcus spp.*, consistent with the global ESKAPE pathogen profile.

Conclusion:

The study highlights a predominance of Gram-negative organisms in ICU infections, with significant antimicrobial resistance, emphasizing the need for regular surveillance and updated antibiograms. Tailored empirical therapy based on local resistance patterns is crucial to improve patient outcomes and support antimicrobial stewardship efforts in resource-limited settings.

Keywords- Antimicrobial, multidrug resistant, enterococcus

Introduction

Antimicrobial resistance (AMR) has emerged as a critical global public health challenge, especially in developing countries where the burden of infections is high and the unregulated use of antibiotics is widespread. Hospitals, particularly intensive care units (ICUs), serve as hotspots for the emergence and spread of multidrug-resistant (MDR) pathogens.¹ In these settings, critically ill patients are more susceptible to infections due to invasive procedures, prolonged hospitalization, and weakened immune defenses.

A significant proportion of ICU infections are caused by a group of highly virulent and resistant organisms known collectively as **ESKAPE pathogens**, which include *Enterococcus*

faecium, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and *Enterobacter* species.² Numerous epidemiological studies have reported a predominance of Gram-negative bacteria in ICU infections, with *Klebsiella pneumoniae*, *Escherichia coli*, *Acinetobacter baumannii*, and *Pseudomonas aeruginosa* being the most frequently isolated. Among Gram-positive organisms, *Staphylococcus aureus* and *Enterococcus* spp. are often encountered.³

Although no specific bacterial species have been conclusively linked to higher ICU mortality rates, adverse outcomes are commonly associated with factors such as advanced age, comorbidities, and delayed initiation of appropriate antibiotic therapy. The increasing prevalence of antimicrobial resistance, fueled by the overuse and misuse of antibiotics, has significantly complicated the management of infections in ICUs worldwide.

An important strategy to improve clinical outcomes in ICUs involves timely administration of empirical antibiotics, guided by regularly updated local antibiograms. These antibiograms are essential components of antimicrobial stewardship programs and play a crucial role in ensuring appropriate and effective empirical therapy, ultimately reducing morbidity and mortality rates in critically ill patients.

Despite the high burden of AMR in low- and middle-income countries, data regarding resistance patterns among ICU patients remain limited. Resistance trends often vary not only between countries but also between hospitals and even among different ICUs within the same hospital. At our tertiary care teaching hospital, no recent surveillance study had been conducted to document the antibiotic susceptibility patterns of ICU pathogens. Hence, the present study was undertaken to determine the spectrum of bacterial isolates from ICU patients and to analyze their antibiotic resistance profiles.

Materials and Methods

This hospital-based, cross-sectional observational study was conducted in the Department of Microbiology, Sharda Hospital, Greater Noida, over a six-month period from October 2023 to March 2024. The study included all clinical samples received from ICU patients, including blood, central line tips, bronchoalveolar lavage (BAL), pleural fluid, cerebrospinal fluid (CSF), ascitic fluid, endotracheal aspirates, pus or tissue, sputum, throat swabs, and urine.

Samples were processed using standard bacteriological techniques. Isolates were identified based on colony morphology, Gram staining, and a series of conventional biochemical tests

such as catalase, oxidase, coagulase, urease, citrate, indole, methyl red (MR), Voges-Proskauer (VP), oxidative-fermentative (OF) test, triple sugar iron (TSI) test, nitrate reduction, and amino acid decarboxylation reactions.

Antimicrobial susceptibility testing was performed by the Kirby-Bauer disc diffusion method on Mueller-Hinton agar, following Clinical and Laboratory Standards Institute (CLSI) 2023 guidelines. Commercially available antibiotic discs (HiMedia Laboratories, Mumbai, India) were used, and results were interpreted based on CLSI breakpoints. Ethical clearance was obtained from the institutional review board prior to the study.

Results

Study population. During the study period, a total of 2,125 samples were received from various ICUs and analysed in the Bacteriology Lab at Sharda Hospital, Greater Noida. The distribution of these samples were as follows- 988 blood samples (46%), 627 urine samples (30%), 420 respiratory samples (20%), and 90 pus samples (4%). (Table 1)

ICU Sample and Pathogen Distribution Overview

Total ICU Samples Collected (n=2125):

- Blood: 988 (46%)
- Urine: 627 (30%)
- Respiratory: 420 (20%)
- Pus: 90 (4%)

Total Clinical Isolates (n=285):

- Respiratory: 131 (46%)
- Blood: 64 (23%)
- Urine: 58 (20%)
- Pus: 32 (11%)

Table No. 1 Organism Distribution by Site

| | Blood (n=64) | Urine (n=58) | Respiratory (n=131) | Pus (n=32) | Total (n=285) |
|--|-----------------|-----------------|------------------------|---------------|------------------|
| | | | | | |

| | | | | | |
|--|-----------------|-----------------|-----------------|-----------------|-----------------|
| E. coli | 8 (12%) | 23 (40%) | 27 (21%) | 11 (35%) | 69 (24%) |
| Acinetobacter spp. | 6 (9%) | 1 (2%) | 54 (41%) | 4 (12%) | 65 (23%) |
| Klebsiella spp. | 10 (16%) | 6 (9%) | 17 (13%) | 5 (16%) | 38 (13%) |
| Pseudomonas spp. | 2 (3%) | 3 (5%) | 21 (16%) | 2 (6%) | 28 (10%) |
| Staphylococcus aureus (MRSA/MSSA) | 17 (27%) | 1 (2%) | 8 (6%) | 2 (6%) | 28 (10%) |
| Enterococcus spp. | 4 (6%) | 23 (40%) | 0 | 1 (3%) | 28 (10%) |
| CONS | 17 (27%) | — | — | — | 17 (6%) |
| Citrobacter spp. | — | 1 (2%) | 4 (3%) | 5 (16%) | 10 (3%) |
| Proteus spp. | — | — | — | 2 (6%) | 2 (1%) |

Table No.2 Antibiotic susceptibility profile of Enterobacteriaceae (n=119)

| Antibiotics | Sensitivity (%) | Resistance (%) |
|-------------------------|------------------------|-----------------------|
| Ampicillin | 8% | 92% |
| Gentamicin | 42% | 58% |
| Tobramycin | 31% | 69% |
| Amoxyclav | 22% | 78% |
| Ceftriaxone | 26% | 74% |
| Cefotaxime | 26% | 74% |
| Cefuroxime | 12% | 88% |
| Cefepime | 22% | 78% |
| Ciprofloxacin | 26% | 74% |
| Levofloxacin | 26% | 74% |
| Amikacin | 41% | 59% |
| Imipenem | 43% | 57% |
| Meropenem | 43% | 57% |
| Piperacillin/tazobactam | 27% | 73% |

| | | |
|----------------|-----|-----|
| Cotrimoxazole | 35% | 65% |
| Ceftazidime | 13% | 87% |
| Aztreonem | 19% | 81% |
| Tetracycline | 26% | 74% |
| Minocycline | 39% | 61% |
| Tigecycline | 43% | 57% |
| Nitrofurantoin | 70% | 30% |
| Fosfomycin | 66% | 34% |
| Norfloxacin | 10% | 90% |

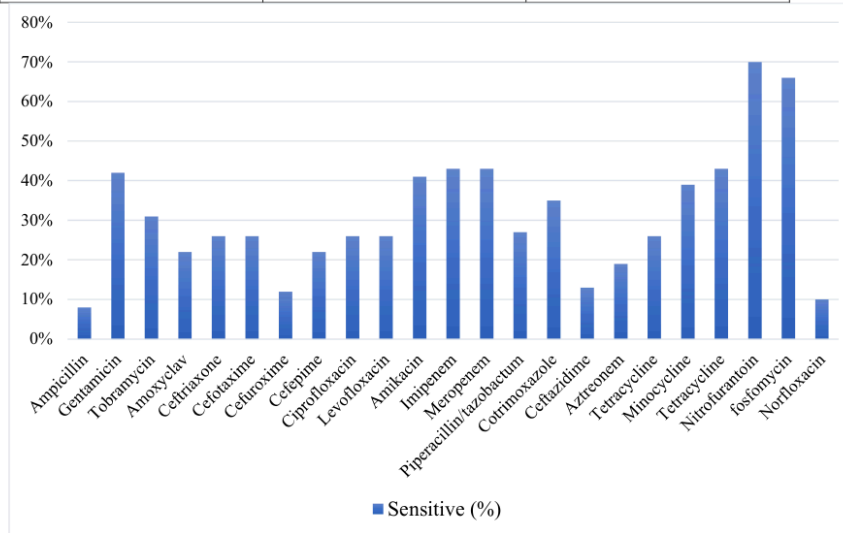


Fig 1-Antibiotic sensitive profile of *Enterobacteriaceae* (n=119)

Non- *Enterobacteriaceae*- Among the 285 isolates, 65 were as *Acinetobacter spp.*, and 28 as *Pseudomonas spp.*

1-*Acinetobacter spp.*

- ✓ A total of 65 *Acinetobacter species* were isolated from 285 isolates. *Acinetobacter spp.* were found to be highly effective for Minocycline (68%) followed by Tigecycline (45%), Cotrimoxazole (15%), Ceftriaxone and Cefotaxime (14%)

whereas, Meropenem, Imipenem, Cefepime and Cefuroxime were least effective (1%) among all the antibiotic agents tested.

- ✓ Nitrofurantoin and Norfloxacin showed resistant to all the isolates of *Acinetobacter* spp. in urinary tract infection. (Table 6)

Table No 3: Antibiotic susceptibility pattern of *Acinetobacter* spp. (n=65)

| Antibiotics | Sensitivity (%) | Resistance (%) |
|-------------------------|-----------------|----------------|
| Ceftazidime | 4% | 96% |
| Ciprofloxacin | 4% | 96% |
| Levofloxacin | 4% | 96% |
| Gentamicin | 4% | 96% |
| Tobramycin | 5% | 95% |
| Imipenem | 1% | 99% |
| Meropenem | 1% | 99% |
| Ceftriaxone | 14% | 86% |
| Cefotaxime | 14% | 86% |
| Cefepime | 1% | 99% |
| Amikacin | 7% | 93% |
| Piperacillin/tazobactam | 7% | 93% |
| Minocycline | 68% | 32% |
| Cotrimoxazole | 15% | 85% |
| Tigecycline | 45% | 55% |
| Cefuroxime | 1% | 99% |
| Tetracycline | 6% | 94% |
| Nitrofurantoin | 0% | 100% |

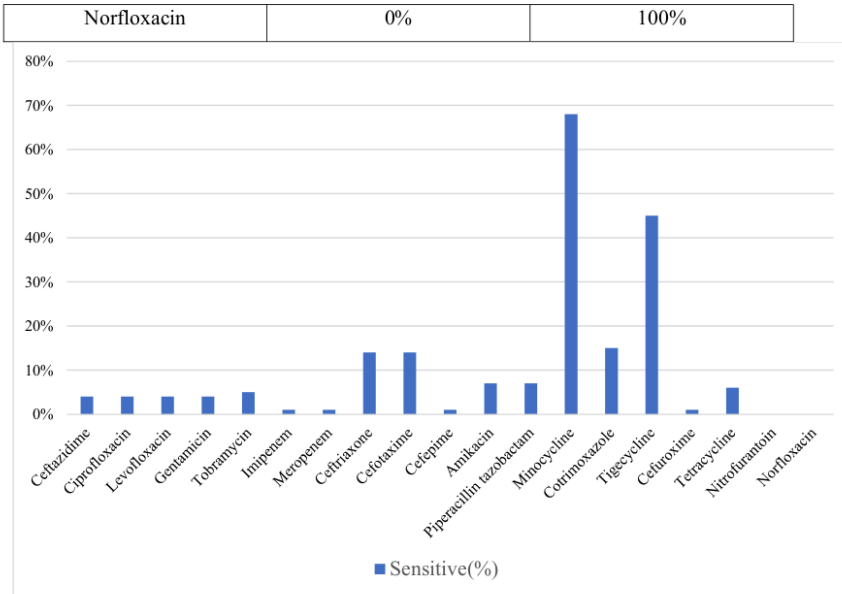


Fig 2- Antibiotic sensitive pattern of *Acinetobacter* spp. (n=65)

2-*Pseudomonas aeruginosa*

- ✓ Aminoglycosides (Amikacin, Gentamicin, Tobramycin) were found to be highly effective (79%, 75%, 75%) followed by Carbapenems (meropenem, imipenem) (75%) Cefepime (75%) and flouroquinolones (Ciprofloxacin, Levofloxacin) (60%) respectively. whereas, Piperacillin-tazobactam was least effective (53%).
- ✓ Nitrofurantoin and Norfloxacin showed resistant to all the isolates of *Pseudomonas aeruginosa* in urinary tract infection. (Table 7)

Table No. 5 Antibiotic susceptibility pattern of *Pseudomonas aeruginosa* (n=28)

| Antibiotics | Sensitivity (%) | Resistance (%) |
|-------------------------|-----------------|----------------|
| Ceftazidime | 58% | 42% |
| Gentamicin | 75% | 25% |
| Tobramycin | 75% | 25% |
| Piperacillin-tazobactam | 53% | 47% |
| Cefepime | 75% | 25% |
| Ciprofloxacin | 60% | 40% |
| Levofloxacin | 60% | 40% |
| Amikacin | 79% | 21% |
| Imipenem | 75% | 25% |
| Meropenem | 75% | 25% |
| Aztreonem | 67% | 33% |
| Nitrofurantoin | 0% | 100% |
| Norfloxacin | 0% | 100% |

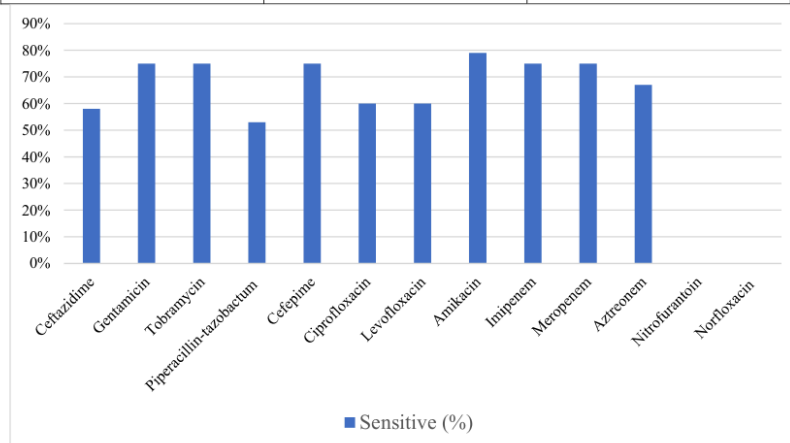


Fig 3- Antibiotic sensitive pattern of *Pseudomonas aeruginosa* (n=28)

Among the 285 isolates, 28 were as *Staphylococcus aureus*, 28 as *Enterococcus spp.* and 17 as *Coagulase negative Staphylococci (CoNS)*.

1-*Staphylococcus aureus* and CoNS

- ✓ Linezolid was found to be highly effective (95%) followed by Vancomycin (86%), Tetracycline (81%), Cotrimaxazole (68%), Gentamicin (63%) and Teicoplanin (46%) whereas, Penicillin was least effective (15%) respectively.
- ✓ Nitrofurantoin and Norfloxacin was found to be highly effective (100%) in urinary tract infections.
- ✓ Fosfomycin was found to be highly effective (66%) in urinary tract infections and respiratory tract infections. (Table 8)

Table 4

| Antibiotics | Sensitivity (%) | Resistance (%) |
|----------------|-----------------|----------------|
| Penicillin | 15% | 85% |
| Cefoxitin | 37% | 63% |
| Vancomycin | 50% | 50% |
| Teicoplanin | 46% | 54% |
| Linezolid | 95% | 5% |
| Gentamicin | 63% | 37% |
| Azithromycin | 34% | 66% |
| Erythromycin | 28% | 72% |
| Tetracycline | 81% | 19% |
| Ciprofloxacin | 32% | 68% |
| Levofloxacin | 32% | 68% |
| Nitrofurantoin | 100% | 0% |
| Clindamycin | 28% | 72% |
| Cotrimaxazole | 68% | 32% |
| Norflox | 100% | 0% |
| Fosfomycin | 66% | 34% |

Antibiotic susceptibility pattern of *Staphylococcus aureus* and CoNS (n=45)

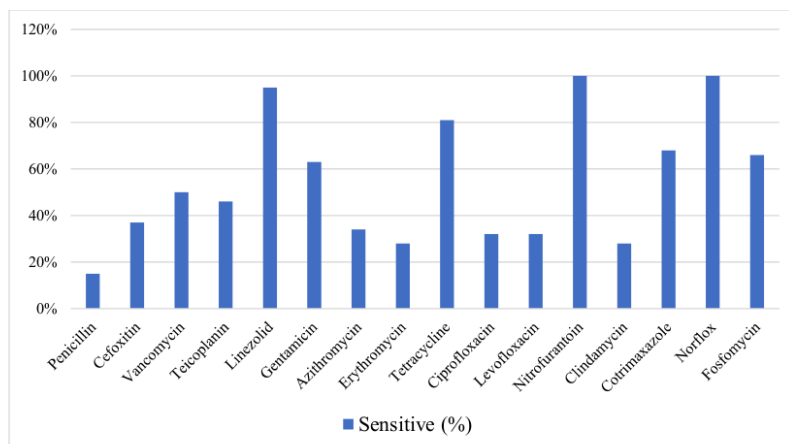


Fig 4- Antibiotic sensitive pattern of *Staphylococcus aureus* and CoNS (n=45)

2-*Enterococcus* spp.

- ✓ Linezolid was found to be highly effective (100%) followed by Teicoplanin (90%), Vancomycin (78%), Ampicillin (33%), High level gentamycin (15%) and High level streptomycin (15%) respectively. Erythromycin showed resistant to all the isolates of *Enterococcus* spp.
- ✓ Nitrofurantoin was found to be highly effective (60%) whereas, Fosfomycin was least effective (18%) respectively and Norfloxacin showed resistant to all the isolates of *Enterococcus* spp. in urinary tract infections. (Table 9)

| Antibiotics | Sensitivity (%) | Resistance (%) |
|-------------------------|-----------------|----------------|
| Ampicillin | 33% | 67% |
| Penicillin | 15% | 85% |
| Linezolid | 100% | 0% |
| Vancomycin | 52% | 48% |
| High level gentamycin | 15% | 85% |
| High level streptomycin | 15% | 85% |
| Ciprofloxacin | 8% | 92% |
| Levofloxacin | 8% | 92% |
| Fosfomycin | 18% | 82% |
| Nitrofurantoin | 60% | 40% |
| Tetracycline | 9% | 91% |
| Teicoplanin | 90% | 10% |
| Erythromycin | 0% | 100% |
| Norflox | 0% | 100% |

Table No.5: Antibiotic susceptibility pattern of *Enterococcus spp.* (n=28)

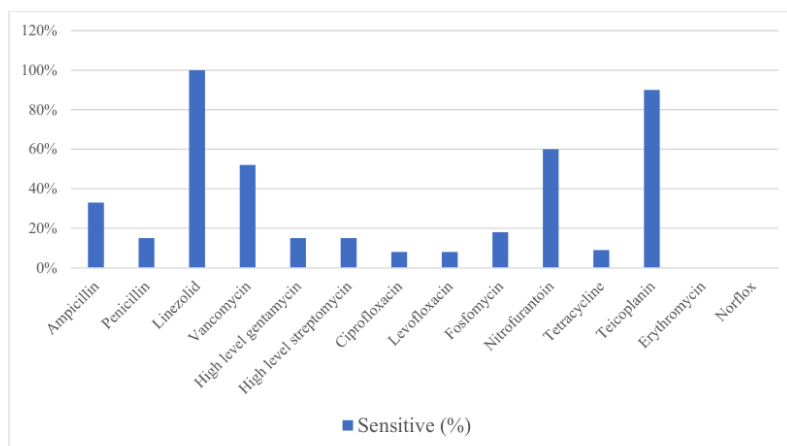
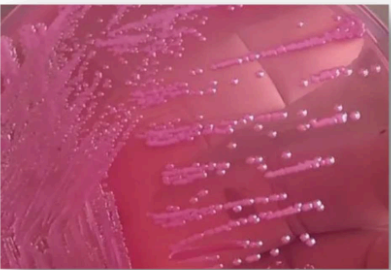
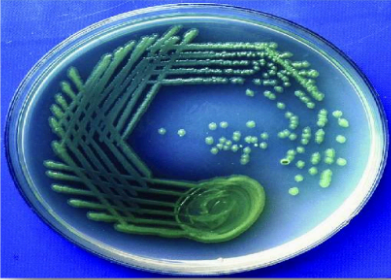


Fig 5- Antibiotic sensitive pattern of *Enterococcus spp.* (n=28)

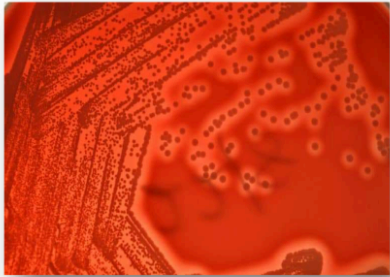
Images

Growth of most isolated Bacteria are shown in the figures given below



Klebsiella spp. on MacConkey's Agar

E. coli on MacConkey's Agar



Staphylococcus aureus on Blood Agar



Enterococcus spp. on Blood Agar



Kirby-Baur AST on Muller Hinton Agar

Discussion:

In this study, out of 2,125 samples, bacterial growth was observed in 285 (13.4%). Among these 285 isolates, the highest frequency was noted in respiratory samples 131 (46%), followed by blood 64 (23%), urine 58 (20%), and pus 32 (11%). A study done by **Negm et al (2021)**⁴ bacterial growth was observed in 45,221. Among these 45,221 isolates, the highest frequency was noted in Blood 14,637 (32.37%), followed by Sputum 13,106 (28.98%), Urine 7379 (16.32%), Wound swab 1240 (2.74%), Pus 5349 (11.83%), Pleural fluid 155 (0.34%), Peritoneal fluid 412 (0.91%), CSF 190 (0.42%), BAL 504 (1.11%), CVC tip 2166 (4.79%), Vaginal swab 33 (0.07%), Stool 50 (0.11%).⁽¹¹⁾ In another study by **Savanur SS and Gururaj H (2019)**⁵ found bacterial growth in 127 (77.0%) out of 165 samples. In their findings, the highest isolation rate was recorded in blood (48), followed by ET aspirates (40), urine (39), sputum (17), pus (11), catheter tips (4), stool (1), ear swabs (2), and vaginal swabs (1).

Among the 64 blood samples analyzed in this study, the most frequently isolated organisms were *Staphylococcus aureus* (including both *MRSA* and *MSSA*) and Coagulase-negative staphylococci (CONS), each with 17 isolates (27%). This was followed by *Klebsiella* spp. with 10 isolates (16%), *E. coli* with 8 isolates (12%), *Acinetobacter* spp. with 6 isolates (9%), and *Enterococcus* spp. with 4 isolates (6%). The least isolated organism was *Pseudomonas* spp., with only 2 isolates (3%) in bloodstream infections. A study done by **Jain Set al. (2022)**⁶ involving 89 isolates reported that the most frequently isolated organism was Coagulase-negative staphylococci with 31 isolates (34.83%), followed by *Staphylococcus aureus* with 21 isolates (23.59%), *Pseudomonas* spp. with 12 isolates (13.48%), *Klebsiella* spp. with 7 isolates (7.87%), and *E. coli* with 6 isolates (6.74%). The least isolated organisms (2.25%) in their study included *Streptococcus* spp., *Enterococcus* spp., *Citrobacter* spp., and *Burkholderia cepacian*.⁽¹³⁾ In another study by **Katyal A et.al (2018)**⁷ A total of 2,028 blood cultures were received from various ICUs. Total positive cultures were obtained in 504 (24.86%) cases. Among the Gram-positive (GP) isolates 288 (57.14%), coagulase-negative *Staphylococci* (CoNS) 55.5% was the most common followed by *Staphylococcus aureus* 34% and *Enterococcus* spp. 10.4%. *Acinetobacter baumannii* 52.3% was the most common Gram-negative (GN) isolate, 216 (42.85%), followed by *E.coli* 27.7%, *Klebsiella pneumoniae* 14.35%, and *Pseudomonas aeruginosa* 5.5%.

In urinary tract infections (UTIs) in this study, *Enterococcus spp.* and *E. coli* were the most frequently isolated organisms, each accounting for 23 isolates (40%). This was followed by *Klebsiella spp.* with 6 isolates (10%), *Pseudomonas spp.* with 3 isolates (5%), *Acinetobacter spp.* with 1 isolate (2%), and *Citrobacter spp.* with 1 isolate (2%). *Staphylococcus spp.* (*MSSA*) was the least isolated organism, with only 1 isolate (2%). A study done by **Deb J. and Debnath S. (2023)**²⁸ identified 45 microbial pathogens from 150 suspected UTI cases. Among the bacterial isolates, *Enterococcus spp.* was the most common, accounting for 33.3%, followed by *E. coli* (29%), *Staphylococcus aureus* (11.1%), *Klebsiella pneumoniae* (8.89%), *Acinetobacter spp.* (2.22%), *Citrobacter freundii* (2.22%), and *Enterococcus faecalis* (2.22%).⁽¹⁵⁾

In the analysis of respiratory samples in this study, *Acinetobacter spp.* was the most frequently isolated organism, accounting for 54 isolates (41%). This was followed by *E. coli* with 27 isolates (21%), *Pseudomonas spp.* with 21 isolates (16%), *Klebsiella spp.* with 17 isolates (13%), and *Staphylococcus aureus* (including both *MRSA* and *MSSA*) with 8 isolates (6%). *Citrobacter spp.* was the least identified organism, with only 4 isolates (3%). A study done by **Padmaja N. and Rao V. (2021)**²⁹ analyzed 135 respiratory samples, of which 52 (58%) showed positive growth. Their findings revealed a predominance of Gram-negative bacteria, with *Klebsiella pneumoniae* being the most common organism with 30 isolates (61%), followed by *Pseudomonas aeruginosa* with 15 isolates (30%) and *E. coli* with 4 isolates (8%). Additionally, the study identified three fungal isolates, all of *Aspergillus niger* (1%).

In skin and soft tissue infections in this study, *E. coli* was the most frequently isolated organism, accounting for 11 isolates (35%), followed by *Klebsiella spp.* and *Citrobacter spp.*, each with 5 isolates (16%). Other organisms included *Acinetobacter spp.* with 4 isolates (12%), *Pseudomonas spp.*, *Staphylococcus aureus* (*MSSA*), and *Proteus spp.*, each with 2 isolates (6%), while *Enterococcus spp.* was the least isolated organism with only 1 isolate (3%). A study done by **Kursheed F. and Tabassum A. (2023)**⁶ analyzing 2,507 samples reported positive cultures in 1,242 cases (49.5%). Among these, 364 were Gram-positive cocci (GPCs) and 878 were Gram-negative rods (GNB). The most common isolate was Methicillin-resistant *Staphylococcus aureus* (*MRSA*) (23%), followed by *Klebsiella pneumoniae* (22.6%), *Pseudomonas aeruginosa* (16.9%), *Enterobacter spp.* (15.5%), and *E. coli* (14.2%).⁽¹⁷⁾

In this study, *E. coli* was the most frequently isolated organism, with 69 isolates (24%), followed by *Acinetobacter spp.* with 65 isolates (23%), *Klebsiella spp.* with 38 isolates (13%), *Pseudomonas spp.* with 28 isolates (10%), *Staphylococcus aureus (MRSA and MSSA)* with 28 isolates (10%), *Enterococcus spp.* with 28 isolates (10%), *CONS* with 17 isolates (6%), and *Citrobacter spp.* with 10 isolates (3%). *Proteus spp.* was the least isolated organism, with only 2 isolates (1%) among various ICU infections.

Summary & Conclusion:

A total of 2,125 ICU samples were processed, yielding 285 microbial isolates. The most common pathogens varied by infection site: *Staphylococcus aureus*, *CONS*, *Klebsiella spp.*, and *E. coli* in bloodstream infections; *Enterococcus spp.* and *E. coli* in UTIs; *Acinetobacter spp.* in respiratory infections; and *E. coli* in skin/soft tissue infections. Overall, *E. coli* was the most frequent isolate (24%), followed by *Acinetobacter spp.* (23%).

Antimicrobial susceptibility patterns revealed carbapenems and tigecycline as the most effective against Enterobacteriaceae, with notable resistance trends in *Acinetobacter spp.* and *Pseudomonas aeruginosa*. Linezolid and vancomycin remained highly effective against *Staphylococcus aureus*, *CONS*, and *Enterococcus spp.*

The study highlights the urgent need for regular culture and sensitivity testing due to evolving resistance patterns, recommending hospital-specific antibiograms to guide empirical therapy in ICU settings.

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