# Antimicrobial Resistance Pattern of Bacterial Pathogens in Intensive Care Unit (ICU) of Tertiary Care Hospital

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## Abstract

Introduction: In ICU the spread of drug resistance has been realized that is related to widespread of antibiotics uses. In ICU the rate of antimicrobial resistance is higher than in general hospital setting. The emergence of MDR bacteria is an increasing problematic cause of health care associated infections in ICUs, not only due to increased morbidity and mortality, but also due to increased treatment costs as result of frequent empirical failure and lengthy hospital stay. Aim: The main purpose of this study was to know prevalence of the drug resistance pattern for the patients admitted in ICUs. Material and Method: The study was conducted in the Department of Microbiology of a tertiary care hospital in Maharashtra during December 2019 to May 2020. In this study patients admitted in ICUs of the hospital who were clinically suspected of having any infection were included. Depending on the clinical suspicion from the patients samples were collected. Samples were subjected to testing for identification and antibiotic susceptibility testing. Result: *E.coli* was the most common organism isolated and shows highly resistance to Amoxcillin+Clavulanic acid, Ciprofloxacin. ESBL producer were 20.17% out of all isolate and 29.07% out of total Gram negative organism. Among all Gram positive organism 13(61.90%) were *Staphylococcus aureus* in which 8(61.54%) were MRSA. *Enterococcus* showed 100% resistance to Erythromycin and Penicillin whereas *Staphylococcus aureus showed* 84.62% and 69.23% resistance to Penicillin and Erythromycin respectively. Conclusion: This study concludes general overview of the incidence and antimicrobial resistance of bacteria isolated from ICU. Gram Negative Organisms are causing more infection than Gram Positive Organisms in ICU patients. Hence gram negative organisms are more resistance to higher antibiotics. So antibiotics are used carefully. Therefore antibiotics policies should be formed for ICU and other critical care facilities.

***Keywords:*** *Intensive Care Unit (ICU), Antimicrobial Resistance, ESBL, MRSA, E.coli, Staphylococcus aureus.*

## Introduction

Antibiotics resistance has emerged as a major factor in predicting outcomes and overall use of resources in intensive care units (ICU) following infections. In ICU the spread of drug resistance has been realized that is related to widespread of antibiotics uses. In ICU the rate of antimicrobial resistance is higher than in general hospital setting[1,2]. Globally ICUs are encountering emergence and spread of antibiotic resistant pathogens and for some pathogens there are few therapeutic options available[3]. Previous epidemiological studies have focused primarily on 2 common Gram positive antimicrobial resistant organisms; Methicillin-resistant *Staphylococcus aureus* (MRSA) and Vancomycin-resistant *Enterococcus* (VRE)[4]. Spellberg *et al* showed that multi drug resistance (MDR) among Gram-negative

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bacteria is becoming even a greater problem in health care facilities[5]. The emergence of MDR bacteria is an increasing problematic cause of health care associated infections in ICUs, not only due to increased morbidity and mortality, but also due to increased treatment costs as result of frequent empirical failure and lengthy hospital stay[6]. Key factors in the management and prevention of MDR bacteria include rational use of antibiotics, hand hygiene, single-use items for individual patients, isolation of patients infected with resistant isolates, environmental cleaning, surveillance, active patient and resource management and education[7,8]. These surveillance programs help to maintain current knowledge of local susceptibilities and relevant treatment options. The family members of Enterobacteriace are the most important human bacterial pathogens which account for the majority of bacteria isolated from clinical samples[9]. It is a matter of concern that this Gram Negative Bacilli (GNB) is rapidly acquiring resistance to one or more traditionally used antimicrobial agent for treatment. Prompt institution of effective empirical antimicrobial therapy is the most important determinant in the successful management of ICU patients infections; inappropriate empirical theraphy affects both patients mortality rates and patient time spent at ICU[10,11]. Staphylosoccus aureus is one of the most common organism causing Nosocomial infections. (i.e. acquired in hospital) and dangerous human pathogen since publication of its role in sepsis by Ogston in 1880 and 1882[12]. Despite the introduction of antimicrobial agent and improvements in Staphylococcal disease frequency and morbidity in the twentieth century, Staphylococci have persisted as an important hospital and community pathogen[13].

The source for multi drug resistance bacteria may include repeated use of higher antibiotics, poor hand hygiene, reuse of items used for individual patients, lack of environmental cleaning, resource management and education and surveillance.

The main purpose of this study was to know prevalence of the drug resistance pattern for the patients admitted in ICUs. This study may provide that might improve the overall management of ICU.

## Material and Method

This study was prospective study conducted in the Department of Microbiology of Jawaharlal Nehru Medical College (Datta Meghe Institute of Medical Sciences), Wardha, in collaboration with Datta Meghe Medical College, Wanadongri; Nagpur; Maharashtra from December 2019 to May 2020. In this study patients admitted in ICUs of the hospital who were clinically suspected of having acquired any infection were included.

In this study was done for total 124 isolates from ICU of 100 patients. Specimens for the culture were taken from ICU patient, depending upon the infection like sepsis, ventilator associated pneumonia, respiratory tract infection and post operative patients. Multiple specimens from different site as well as in different time were taken from the patient having multiple infections.

Samples like blood, urine, pus and CSF etc. were taken depending upon the type of infection. Samples were received in the microbiology laboratory for the culture in sterile universal container. Initially strains were identified based on the morphological behavior of the isolates on various differential media.

The specimens were inoculated on 5% sheep blood agar, MacConkey agar and incubated aerobically at 37ºC for 18 to 24 hours. Chocolate agar plates were incubated at 37ºC in 5% $CO_2$ for 18 to 24 hours. For blood culture 5-10 ml of blood for adult were collected and processed using the BACTEC 9050 blood culture system (Becton Dickinson, Maryland, USA). If growth is displayed as positive, then it is sub-cultured on appropriate media. Organism's identification was done by using routine biochemical test like catalase, Oxidase, citrate, indole, urease etc. Antibiotic susceptibility testing was done by Kirby-Bauer method using Muller Hinton Agar (MHA). Clinical Laboratory Standards (CLSI) interpretive criteria were used for susceptibility results[14]. Quality control was performed by using reference strains of *Staphylococcus aureus* ATCC 25923*, Escherichia coli* ATCC 25922 and *Pseudomonas aeruginosa* ATCC 27853 to confirm consistency of materials, methods, and results[14].

## Results

In vitro susceptibility data of 124 isolates obtain from ICU over the period of the study. Among 100 samples of 100 patients from ICU 62(62%) male and 38(38%) females with age ranging from 20 years to 75 years (average 40-50years old) were studied.

**Table no 1. Showing Percentages of the different cases in the ICU**

| Cases | Percentage (%) |
|---|---|
| Respiratory tract infections | 23 |
| Urinary tract infection | 20 |
| Road traffic accidents | 3 |
| Sepsis | 37 |
| Those undergoing surgery for complicated diseases | 17 |

**Table no 2. Microorganisms isolated from 100 samples of 100 patients from ICU according to the site of infection**

| Microorganism | Urinary tract no. (%) | Respiratory tract no. (%) | Bloodstream no. (%) | Wound no. (%) | Other sites(*) no. (%) | Total no. (%) |
|---|---|---|---|---|---|---|
| E.coli | 12(41.38) | 5(17.24) | | 5(17.24) | 7(24.14) | 29(23.38) |
| Pseudomonas spp | 8(40) | 3(15) | | 1(5) | 8(40) | 20(16.13) |
| Klebsiella spp | 4(23.53) | 8(47.09) | | 1(5.88) | 4(23.53) | 17(13.71) |
| Acinetobacter spp | 5(29.41) | 2(11.76) | 1(5.88) | 2(`11.76) | 7(41.18) | 17(13.71) |
| Staph.aureus | 4(28.57) | 3(21.43) | 1(7.1429) | 2(14.29) | 3(21.43) | 14(11.29) |
| Candida non albicans | 5(41.67) | 4(33.33) | 1(8.33) | 2(16.66) | | 12(9.677) |
| Enterococcus | 7(100) | | | | | 7(5.645) |
| Candida albicans | | 2(50) | | | 2(50) | 4(3.226) |
| Proteus mirabilis | | | | 1(50) | 1(50) | 2(1.613) |
| Providencia Spp | 1(100) | | | | | 1(0.806) |
| Aspergillus spp | | 1(100) | | | | 1(0.806) |
| TOTAL | | | | | | 124 |

(*) Cerebrospinal fluid, Peritoneal fluid, Asitic fluid, Pleural fluid, Abdominal fluid, Endotracheal Secretion, Endotracheal tube and Tip.

Out of 124 isolates 86(69.35%) were Gram negative organisms, 21(16.94%) were Gram positive organisms and 17 were Fungus (13.71%). Among all Gram positive organism 13(61.90%) were *Staphylococcus aureus* in which 8(61.53%) were MRSA and 5(38.46%) were CONS among all gram positive organism isolates respectively. The most frequent species isolated from infections in ICU was *E.coli,* followed by *Pseudomonas spp, klebsiella spp, Acinetobacter spp, Enterococcus, Proteus mirabilis* and *Providencia spp* which were 23.38%, 16.13%, 13.71%, 13.71%, 5.65%, 1.61% and 0.81% respectively. ESBL producer were 25(20.17%) out of all isolate and 29.07% out of total Gram negative organism. The most frequent species isolated from infections in ICU was E.coli as shown in table no 2 and table no 3. .

**Table no 3. Showing distribution of organisms in ICU**

| Name of organism | Number(%) |
|---|---|
| E.coli | 29(23.38) |
| Pseudomonas spp | 20(16.13) |
| Klebsiella spp | 17(13.71) |
| Acinetobacter spp | 17(13.71) |
| Staph.aureus | 13(10.48) |
| Methicillin-resistant Staph. aureus (MRSA) | 8 (6.45% among all isolates and 61.54% among all Staph isolates) |
| Candida non albicans | 12(9.68) |
| Enterococcus | 7(5.65) |
| Candida albicans | 4(3.23) |
| Proteus mirabilis | 2(1.61) |
| Providencia Spp | 1(0.81) |
| Aspergillus spp | 1(0.81) |
| **Total** | **124** |

**Table no 4. Showing the resistance pattern of common antibiotics against isolated Gram positive pathogens**

| Antibiotics | Staphylococcus aureus (%) | Enterococcus (%) |
|---|---|---|
| Erythromycin | 69.23 | 100.0 |
| Penicillin | 84.62 | 100.0 |
| Cortimoxazole | 61.54 | 28.57 |
| Linezolid | 15.38 | 00.00 |
| Oxacillin | 61.54 | 85.71 |
| Vancomycin | 00.00 | 00.00 |
| Levofloxacin | 30.77 | 85.71 |
| Gentamicin | 61.54 | 85.71 |
| Doxycycline | 30.77 | 71.43 |

**Table no 5. Showing resistance pattern of common antibiotics against isolated Gram negative pathogens**

| Antibiotics | E.coli (%) | Klebsiella spp(%) | Acinetobacter spp(%) | Proteus mirabilis (%) | Providencia spp(%) | Pseudomonas spp(%) |
|---|---|---|---|---|---|---|
| Amoxicillin + Clavulanic Acid | 100.0 | 94.12 | 94.12 | 50.00 | 100.0 | - |
| Gentamicin | 65.52 | 82.35 | 88.24 | 50.00 | 100.0 | 35.29 |
| Amikacin | 37.93 | 52.94 | 70.59 | 50.00 | 100.0 | 50.00 |
| Cefuroxime | 100.0 | 88.24 | 88.24 | 50.00 | 100.0 | - |
| Cefepime | 96.55 | 82.35 | 88.24 | 50.00 | 100.0 | 65.00 |
| Cefotaxime | 96.55 | 70.59 | 94.12 | 50.00 | 100.0 | - |
| Ciprofloxacin | 100.0 | 70.59 | 82.35 | 00.00 | 100.0 | 70.00 |
| Imipenem | 00.00 | 00.00 | 35.29 | 00.00 | 00.00 | 00.00 |
| Cotrimoxazole | 93.10 | 82.35 | 88.24 | 00.00 | 100.00 | - |
| Ceftazidime | - | - | - | - | - | 60.00 |
| Piperacillin | - | - | - | - | - | 45.00 |
| Piperacillin + Tazobactam | - | - | - | - | - | 45.00 |
| Aztreonum | - | - | - | - | - | 75.00 |

**Note:** (-) = Antibiotics not used.

## Discussion

This study is based on the antimicrobial resistance and multidrug resistance of the organism isolated from ICU. Antibiotics are most commonly prescribing drugs in ICU which producing the strength of resistance to the organism.

Reduction of antimicrobial resistance in ICUs has been a target for all ICUs because it increases outcomes and cost for patients in terms of expenses for costly antibiotics as well as length of stay in ICUs. This study shows Imipenem was the drug which was increasing resistance to *Acinetobacter spp* and Vancomycin has 0% resistance in case of gram positive organism.

Most isolates recovered from the urine specimens followed by the respiratory specimens and other specimens. Total 100 clinical isolates were analyzed. The most common isolates observed in this study were *E.coli* (23.38%), *Pseudomonas spp* (16.13%), *Klebsiella spp* (13.71%), *Acinetobacter spp* (13.71%), *Staphylococcus aureus* (10.48%), *Candida non albicans*(9.68%), *Enterococcus* (5.65%), *Candida albicans* (3.23%), *Proteus mirabilis* (1.61%), *Providencia Spp*1(0.81%) & *Aspergillus spp*1(0.81%). The incidence of Gram-

positive and Gram-negative bacilli in this study was 15% and 85% respectively. The *Acinetobacter spp* show the increasing resistance in Imipenem (35.29%) where as other shows 100% sensitive.

In the studied of Zaveri Jitendra et.al[15] showed *E.coli* was the commonest isolated organism in the study showing commonly sensitive to Amikacin. In the study *Citrobacter species* (66.7%) was most common multidrug resistant organism followed by *Proteus* and *Enterococcus* (33.3%, 33.3%) respectively.

Another studied of Trivedi TH et.al[16] showed ICU from Mumbai found enteric gram negative organism as the commonest isolates (61.9%) followed by *Staphylococcus aureus* (29.8%).

Similar studied of Singh AK et .al[17] from Varanasi showed that the enteric gram negative bacilli were uniformly resistance to beta lactam- beta lactamase inihibitors combinations. Ciprofloxacin and Ceftriaxone showed resistance that range from 50-100% and 25-83.3% respectively. *Staphylococcus showed* 100% resistant to Penicillin and Tetracycline, 80% resistant to Cotrimoxazole, 60% resistant to Erythromycin and Gentamicin and 40% resistant to Amikacin. *Acinetobacter spp* showed highly resistant to most of the antibacterial agents except Gentamicin while *Pseudomonas spp*. showed 75% resistance to it.

In another studied of Azad Jammu et at[18] showed Ceftazidime resistance was decreased in *Pseudomonas* and other non-fermenting gram-negative bacteria (NFGNB). In NFGNB third generation resistance of Cephalosporin seemed to be reducing; however resistance to Carbapenem appeared to be increasing, possibly due to their increasing in use.

Studied of Nidhi Goel Et al[19] showed *Pseudomonas aeruginosa as* commonly isolate bacteria which followed by *Acinetobacter baumanni* and *Klebsiella pneumoni.* Gram Negative Bacteria showed high rate of resistance to ciprofloxacin, ceftazidime, co-trimoxazole and combination of amoxycycillin/clavulanic acid. meropenem and doxycycline was noted as least resistance.

**Limitations:** This investigation has certain limitations. There was major shortcoming resistance rates calculated from isolates recovered exclusively from blood cultures were essentially identical to rates derived as isolates from other sites. Patient demographic information like primary source of infection, history of antibiotic used was not available as result so analysis could not be performed which could take these important factors into account. Test isolates were not routinely available for ancillary molecular characterization of either resistance determinants or clonal relationships. Not with standing these shortcomings, it is believed that this study provides a unique, objective, and systematic view of the scope and magnitude of the problem of antimicrobial resistance among GNB as well as GPC in ICU patients today.

## Conclusion

This study concludes general overview of the incidence and antimicrobial resistance of bacteria isolated from ICU. *E.coli* was the most common organism isolated and shows highly resistance to Amoxcillin+Clavulanic acid, Ciprofloxacin whereas Erythromycin and Penicillin shows highly resistance to *Enterococcus*. This studied also shows the emergence and rates of Multi Drugs Resistance (MDR) organisms and emphasizes the importance of timely clinical and bacteriological monitoring among patients in a critical care situation. Infection control programs should focus on preventing infections in patients who are at highest risk of infection because of exposure to certain procedures and medical devices. Frequent hand washing and good aseptic technique should be reinforced for all health care personnel. Hence gram negative organisms are more resistance to higher antibiotics. So antibiotics are used carefully. Therefore antibiotics policies should be formed for ICU and other critical care facilities.

**Ethical Clearance:** Taken from institutional ethics committee.

**Source of Funding:** Self.

**Conflict of Interest:** nil.

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