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Research Article

PREVALENCE OF BACTERIAL INFECTIONS AND THEIR ANTIBIOTIC SUSCEPTIBILITY PATTERN OF PATIENTS ADMITTED IN INTENSIVE CARE UNIT

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Abstract- Background: Infections in Intensive care unit (ICU) patients remain as a great challenge to the treating health care providers due to their high incidence and mortality rates. Aim: The aim of the present study is to evaluate the prevalence and the antibiotic susceptibility pattern of bacterial infections from patients admitted in ICU. Materials and methods: The study was conducted in a tertiary care hospital, Chennai. Clinical samples were collected from 100 patients admitted in the ICU with clinical symptoms of infection and processed in microbiology laboratory for bacterial culture and sensitivity. The organisms were identified using standard microbiological methods. Results: Out of the 100 samples processed, 61 samples showed bacterial growth. The common infections in ICU were found to be urinary tract infections, septicaemia, respiratory infections followed by soft tissue infections. *Escherichia coli, Klebsiella, Staphylococcus aureus,* Coagulase negative *Staphylococcus* (CONS) and *Pseudomonas* were the commonly isolated organisms. Conclusion: Patients in ICU are reported to be highly susceptible to infections. Drug resistance is found to be higher among the isolates. Strict adherence to Hospital infection control protocol, proper monitoring of the patients and rational use of antibiotics help in prevention of infections to a greater extent.

Keywords- *Bacterial organisms, Antibiotic susceptibility pattern, Intensive care unit*
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Introduction

The discovery of penicillin by Alexander Fleming paved way for the concept of antimicrobials following which the morbidity and mortality due to microbes dropped drastically and was considered as a medical evolution. Several decades after the discovery, the emergence of multi-drug resistant microbes has caused global concern and threat to the medical field, bringing attention and focus towards it.

The infections of the drug resistant organisms cause failure of antibiotic treatment which has again raised the values of morbidity and mortality to the peaks. The conceptualization of drug resistance and minimal range of treatment has created a great challenge to the medical field.

Infections are one of the commonly occurring complications for a hospitalised patient [1]. Further, ICUs are often considered to be the epicentre of development, amplification and dissemination of drug resistance of microorganisms [2,3]. ICU is the common habitat for critically ill patients who are prone to infection and infection causing microorganisms.

It has been found that a patient admitted in ICU has higher risk of acquiring infection compared to an average patient. ICU contributes to 20-25% of the hospital acquired infections [4,5]. The various risk factors for this include immunocompromised status, use of immunosuppressive drugs, invasive devices, irrational use of antibiotics, prolonged hospital stay, etc.

Though standard infection protocols like hand hygiene, use of personal protective equipment, transmission-based precaution of contact, droplet and air borne disease prevention are used regularly the spread of infection in ICU becomes an invulnerable [6]. Critically ill patients are particularly prone to infection because of exposure to multiple invasive procedures [7,8]. The use of broad-spectrum antibiotics, that is closely related to the development and spread of the drug-resistant microorganism, reporting 30-60% rate of inappropriate or incorrect antibiotic prescription [9-11].

The prevalence of organisms causing infections in various hospitals differ from one another. The knowledge about the prevalence of microorganism in the hospital as well as their antimicrobial susceptibility pattern is very important for devising the antibiotic policy for that hospital. Therefore, the present study is aimed to know the prevalence of organisms in infections in patients admitted in ICU of a tertiary care hospital in Chennai and to determine their antibiotic susceptibility pattern.

Materials and methods

The study was conducted in a tertiary care hospital over a period of 9 months from April 2019 to December 2019. Clinical samples were collected from the patients admitted in ICU during the study period and were processed immediately in the Microbiology laboratory.

Bacterial isolation and identification: The samples were examined under direct microscopy and were cultured aerobically. The clinical samples were inoculated in Nutrient agar, MacConkey agar and Blood agar plates and incubated at 37°C aerobically for 24 to 48 hrs. After 24 hours, the plates were examined for the presence of growth if any. The bacterial organisms were identified using standard biochemical and microbiological techniques. If there is no appreciable growth, the plates were further incubated for 48 hours before reporting as no growth.

The antibiotic susceptibility testing

The antibiotic susceptibility of the isolates was performed using disc diffusion technique by Kirby Bauer method as per Clinical and Laboratory Standards Institute (CLSI) guidelines. The bacterial suspension prepared from the colony grown in culture plate was inoculated as lawn culture on the Mueller-Hinton agar plate and antibiotic discs were placed on it, and incubated at 37°C overnight.

The zone of inhibition around the antibiotic discs were measured and interpreted as per CLSI guidelines.

Results

A total of 100 patients admitted in ICU were included in the study. The 100 samples in our study included 45 samples from male patients and 55 samples from female patients. Most of the patients included in the study were elderly patients more than 60 years of age (51%) as shown in [Table-1]

Table-1 *Age wise distribution of cases*

Age	Number	Percentage
<20	1	1%
20-40	14	14%
40-60	34	34%
>60	51	51%
Total	100	100%

Table-2 *Clinical specimen distribution*

Specimen	Number	Percentage
Urine	51	51%
Blood	31	31%
Sputum	8	8%
Wound	7	7%
Stool	2	2%
Pleural Fluid	1	1%

Table-3 *Organisms isolated from various clinical specimen*

Organism	Urine	Blood	Stool	Sputum	Wound	Pleural Fluid
Escherichia Coli	8	2	0	0	2	0
Proteus	2	1	0	0	0	0
Pseudomonas	2	3	0	2	0	0
Enterobacter	3	1	0	0	0	0
Klebsiella	3	3	0	3	2	0
Acinetobacter	1	2	0	0	0	0
Morganella	1	0	0	0	0	0
Staphylococcus aureus	0	2	0	0	0	0
Methicillin Resistant *Staphylococcus aureus*	2	4	0	0	2	0
Coagulase Negative *Staphylococcus*	1	8	1	0	0	0
No growth	28	5	1	3	1	1

Table-4 *Distribution of organisms isolated in the study*

Organism	No. of Isolates	Percentage
Escherichia coli	12	12
Klebsiella	11	11
Pseudomonas	7	7
Enterobacter	4	4
Acinetobacter	3	3
Proteus	3	3
Morganella species	1	1
Staphylococcus aureus	10	10
Coagulase Negative Staphylococcus	10	10
No growth	39	39

Out of the 100 cases, 61 patients developed infection. The samples from 39 patients showed no growth [Table-4]. Infections due to Gram negative organisms (41%) were found to be more common than Gram positive organisms (20%) [Table-4].

Discussion

Emerging drug resistance among the microorganisms is a concept of great concern across the globe especially in the ICU where the patients are highly vulnerable. This study thus focuses on the Antimicrobial resistance expressed to the different drugs by the microbes isolated from the clinical specimens taken from the ICU patients. In our study, more than half of the patients (51%) in the ICU infected by the microbes were above the age of 60.

Table-5 *Antibiotic susceptibility pattern of Gram-positive organisms*

Antibiotics	*Staphylococcus aureus* (10)	CONS (10)
Linezolid	S=9 R=1	S=10 R=0
Cotrimoxazole	S=4 R=6	S=7 R=3
Erythromycin	S=4 R=6	S=4 R=6
Clindamycin	S=7 R=3	S=5 R=5
Chloramphenicol	S=8 R=2	S=9 R=1
Cefoxitin	S=2 R=8	S=0 R=10
Gentamicin	S=8 R=2	S=8 R=2
Tigecycline	S=10 R=0	S=10 R=0
Nitrofurantoin	S=6 R=4	S=9 R=1
Ciprofloxacin	S=5 R=5	S=4 R=6
Penicillin	S=2 R=8	S=1 R=9

This was similar to the research done in Vietnam in which the average age was found to be 71 years.[12] It was also seen that least number of ICU patients was recorded in the age less than 20 and number of patients increased as age increased. The number of female resistant patients (55%) were found to be 10% more than the male resistant patients (45%). This was contradictory to the previously published articles which cited male patients more than the female patients [13-15].

Urine and blood together accounted 82% of the clinical specimen collected in our study, of which urine accounting the maximum with 51% of the clinical specimens and blood accounting 31%. The rest 18% of the clinical specimen were the other specimens such as sputum, wound, stool and pleural fluid with a distribution of 8%,7%,2% and 1% respectively.

39% of the study samples showed no growth and the remaining 61% of the sample proved the presence of different microorganisms and their variable pattern of resistance.

In our study the number of Gram-negative bacteria were more than the Gram-positive bacteria, similar to another study [16] as the former are known to develop resistance more rapidly and extensively than the latter [17,18]. *E.coli* (12%) and *Klebsiella* (11%) were the common organisms isolated from the specimen collected. Similar results were observed among the urine sample of another research [13]. But in few other reports, *Pseudomonas* was found to be the predominant pathogen isolated [19,20] which was only 7% in our study. Apart from these, organisms such as Methicillin Resistant *Staphylococcus aureus* (MRSA) (8%), *Pseudomonas* (7%), CONS (10%), Proteus (3%), *Enterobacter*(4%) and Morganella (1%) were also isolated from the samples.

On observing the distribution of organisms isolated from various clinical specimens, *E.Coli*, *Klebsiella* and *Enterobacter* were the predominant microorganisms isolated from urine. The similar pattern of distribution of organism was also observed previously, in which *E.Coli* and *Klebsiella* were increasingly reported from urine [13]. MRSA and CONS were the predominant microorganisms isolated from the blood.

Antimicrobial resistant pattern was also observed in different species. In our study it was seen that almost all the *E.Coli* isolates were resistant to Amoxicillin and showed varying susceptibility to the other drugs. Sensitivity was greater to meropenem, piperacillin, gentamicin, amikacin, cefotaxime and ciprofloxacin for *E.Coli*. This result also matched with other research which also found *E.Coli* having comparatively higher sensitivity to cefotaxime, gentamycin, amikacin, ciprofloxacin [16]. But our research was contradictory to the research which found *E.Coli* being resistant to all cephalosporin and resistance to ciprofloxacin was observed in concurrence with cephalosporin [21] which was not true in our study. *Klebsiella* was the second most common Gram-negative isolate in our study.

Table-6 *Antibiotic susceptibility of Gram-negative organisms [NT – Not Tested]*

Antibiotics	*Escherichia coli* (n=12)	*Proteus* (n=3)	*Pseudomonas* (n=7)	*Enterobacter* (n=4)	*Klebsiella* (n=11)	*Acinetobacter* (n=3)	*Morganella* (n=1)
Ampicillin	S=5, R=7	S=2, R=1	S=5, R=2	S=0, R=4	S=0, R=11	S=0, R=3	S=0, R=1
Amoxycillin Clavulanic acid	S=4, R=8	S=1, R=2	S=5, R=2	S=0, R=4	S=2, R=9	S=0, R=3	S=0, R=1
Amikacin	S=11, R=1	S=3, R=0	S=6, R=1	NT	S=7, R=4	S=3, R=0	S=0, R=1
Piperacillin Tazobactum	S=12, R=0	S=3, R=0	S=6, R=1	S=2, R=2	S=3, R=8	S=2, R=1	S=0, R=1
Imipenem	S=10, R=2	S=3, R=0	S=6, R=1	S=2, R=2	S=6, R=5	S=3, R=0	S=0, R=1
Meropenem	S=11, R=1	S=3, R=0	S=6, R=1	S=2, R=2	S=6, R=5	S=3, R=0	S=0, R=1
Gentamicin	S=10, R=2	S=2, R=1	S=6, R=1	S=2, R=2	S=4, R=7	S=2, R=1	S=0, R=1
Ciprofloxacin	S=8, R=4	NT	S=4, R=3	S=1, R=3	S=6, R=5	S=3, R=0	NT
Tigecycline	S=12, R=0	NT	S=7, R=0	NT	S=10, R=1	NT	NT
Cotrimoxazole	S=6, R=6	S=3, R=0	S=4, R=3	S=3, R=1	S=1, R=10	S=0, R=3	S=0, R=1
Ceftriaxone	S=9, R=3	S=3, R=0	S=6, R=1	NT	S=6, R=5	S=1, R=2	S=0, R=1
Cefotaxime	S=8, R=4	S=3, R=0	S=6, R=1	S=1, R=3	S=6, R=5	S=1, R=2	S=0, R=1
Cefuroxime	S=9, R=3	S=2, R=1	S=6, R=1	S=2, R=2	S=4, R=7	S=1, R=2	S=0, R=1
Ceftazidime	S=8, R=4	S=3, R=0	S=4, R=3	S=2, R=2	S=3, R=8	S=0, R=3	S=0, R=1

In few other studies, *Klebsiella* was found to the most common isolate [16]. There was greater resistance of *Klebsiella* to ampicillin, amoxicillin clavulanic acid and clotrimoxazole in our study. Carbapenem drugs such as imipenem and meropenem are usually reserved to resistant microbes and severely ill patients, but the organisms have started showing higher resistance to these drugs too. In a study by Tran *et al, Klebsiella* was found to have low resistance to amikacin and higher resistance to ceftriaxone [12] but in our study it was found to be almost equal.

Pseudomonas is one important organism known to cause hospital acquired diseases. *Pseudomonas* was found to show greater susceptibility to Meropenem, Gentamicin, Tigecycline, Ceftriaxone and hence these drugs can be used in the treatment of pseudomonal infections. Gentamicin was found to be the most effective drug for *pseudomonas* infection in another research also [16]. In our study the *Enterobacter* species had complete resistance to ampicillin and amoxicillin clavulanic acid. The presence of multi-drug resistant *Enterobacter* in ICU was also noted in previous studies [22-24] and *Enterobacter* species were found to be more resistant as compared to *Escherichia coli* [23-26]. Proteus was found to show greater resistance to amoxicillin clavulanic acid.

Acinetobacter is also known to cause hospital acquired diseases and hence hospital stains are mostly drug resistant. Acinetobacter was not a predominant microorganism isolated in our study but several other studies had them predominant [12, 13]. The susceptibility rate of Acinetobacter is low and is found to be resistant to most of the drugs. It showed greater resistance to ampicillin, amoxicillin clavulanic acid, cotrimoxazole, and ceftazidime. Acinetobacter was found to demonstrate increasing emergence of imipenem resistance in other study [27]. In our study Acinetobacter was completely susceptible to imipenem, meropenem, amikacin and ciprofloxacin.

Antibiotic susceptibility pattern showed that majority of Gram positive organisms were resistant to penicillin which was also observed in other research[27], but few other studies showed varying levels of resistance of penicillin's [28-31]. It was also observed that none of the isolate was resistant to vancomycin. MRSA isolates were highly susceptible to vancomycin, chloramphenicol and linezolid. Thus, vancomycin and chloramphenicol can be used in MRSA infections. 100% susceptibility to vancomycin and linezolid was observed in few of other reports [32-35]. *Staphylococcus aureus* was found to be susceptible to most of the routine drugs. CONS isolates showed a good susceptibility to linezolid, trimethoprim and nitrofurantoin and showed a higher resistance to erythromycin, ciprofloxacin and cefoxitin.

Conclusion

Intensive care unit is a place where critically ill patients are admitted who are more vulnerable for acquiring infections. Nosocomial infections and the development of antibiotic resistance among the ICU isolates are few of the major limiting factors in patient's clinical outcome, resulting in prolonged hospital stay and economic burden. Increasing trends of antibiotic resistance is a global threat. Minimisation of occurrence of infections is a great challenge and goal of the treating physicians in ICU. Failure of antibiotic treatment and rise in infections due to drug resistant organisms may lead to increase in morbidity and mortality. Appropriate and judicial usage of antibiotics according to the patient's culture and susceptibility report is rather essential to ensure optimal outcome of the patients as well as prevention of emergence of drug resistant pathogens. Effective surveillance, strict adherence to antibiotic policies and proper hospital infection control measures are the need of the hour.

Application of research

Identification of bacterial infections and their antibiotic susceptibility pattern would help in appropriate management of critically ill patients in ICU and framing antibiotic policy and infection control plan for hospitals.

Research category: Medical Microbiology

Abbreviations: ICU-Intensive care unit
CONS-Coagulase Negative *Staphylococcus*
CLSI - Clinical and Laboratory Standards Institute
S-Susceptible, R-Resistant, NT-Not tested
MRSA-Methicillin Resistant *Staphylococcus aureus*

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